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NON-POLAR DYNAMOS IN AMERICA.

THIS subject of perennial interest to the budding electrical engineer has received more than usual attention at the meeting of the American Institute of Electrical Engineers in the city of Philadelphia, where a paper was read on the history, progress, and prospects of the non-polar dynamo, otherwise called the uni-polar dynamo by the authors of the paper, Prof. Crocker and C. H. Farmley.

Uni-polar is, however, a nonsensical term. No such thing in nature exists as a uni-polar magnet, whereas the electrical engineer, since the introduction of the transformer, has become quite familiar with the non-polar magnet in the form of closed magnetic circuits.

Polarity in magnets ought to be forgotten in dynamo and motor designing, and magnetic flux only considered. The direction of the flux, not the polarity, determines the questions to be treated in electro-magnetic induction. There is only one case in which polarity can be properly considered of any importance, and that is in the science of the mariner's compass. It is sometimes convenient to mark out the position of points from which a magnetic flux flows from one body and the position of the points at which it enters another body, and we may mark the leaving points N, and the entering points S, arranging for the excitation accordingly.

The paper referred to did not advance the science of the subject in any way, nor did it bring forward anything new in non-polar dynamos.

The authors contented themselves by reviewing devices already well known, and making some suggestions towards new designs, which, however, upon examination, will be found to be old, and to have been often proposed. The extreme simplicity of the non-polar dynamo takes the first place amongst its supposed advantages, but this advantage is altogether a delusion, for with the extreme simplicity we have extreme uselessness; in its simplicity it generates only 2 or 3 volts at a high speed of driving, and the collection of the current presents difficulties evidently not understood by the authors. An examination of the proposals towards multiplying the E.M.F. in every case leads directly to a construction which is more complicated, and certainly less perfect, than that in an ordinary bar armature and commutator. What is the Siemens tube non-polar dynamo with the tube slit up, but a bar armature with a set of ring commutators? What would a series of concentric insulated tubes be, with outside connections through brushes, but a complicated bar armature and commutator?

The proposal to couple a number of non-polar dynamos in series is the best one; but it seems to us simpler to couple bars on one armature in series, for what is each bar on an armature but the same thing as the disc in a non-polar machine? The number of dynamos in series would need to be almost as great as the bars in series on an armature, and

instead of one commutator and one pair of brushes it would be necessary to collect at every machine. Any way we look at the question the simplicity disappears as soon as more than 2 or 3 volts are required.

Whether hysteresis would play any part in the non-polar dynamo we do not know, but Foucault currents certainly do exist, because the armature gets warm on open circuit, and armature reaction takes place to a great extent, as was proved some time ago by direct experiments, by running a solid iron bar 3 inches in diameter at 22,000 to 25,000 revolutions per minute in a Forbes's field-magnet. On open circuit the E.M.F. was, if we remember correctly, 5 volts; on closed circuit, giving about 300 ampères, the volts fell to 3. This fall could not be due to internal resistance in the armature, and must have been due to armature reaction. Another interesting point not referred to in the paper is this: if in a disc type of non-polar machine the current is not collected equally and evenly all round the periphery, and the leading-off wires not taken away properly, the armature reaction is greater than when these precautions are taken; in fact, the non-polar machine is more sensitive to disturbances than might be supposed, and one great difficulty is the uneven distribution of the large current in the disc, arising from the collectors being unequally applied at the periphery. But even granted that no difficulties such as hysteresis, Foucault currents, or armature reactions exist, and that the efficiency of the non-polar machine might be higher than a large bar armature machine, what could we possibly expect to gain? A good machine of common type does not lose more than 3 to 5 per cent. from these causes, so that on the score of efficiency only about 5 per cent. would be the extent of any advantages in that direction in a non-polar design.

Another proposal made by the authors, and which we have seen before, is to charge storage cells in parallel with the large current and discharge in series at higher pressure. Just think for a moment what the efficiency would be then, in order to get the advantages of a non-polar dynamo over a bar armature machine; is it worth while to throw away 40 per cent. of the energy in storage, to gain 3 to 5 per cent. in a non-polar dynamo? The efficiency of the non-polar dynamo and storage battery transformer combination could not possibly be higher than 60 per cent.

From the time of Faraday down to that of his latest disciple it is safe to affirm that every electrical engineer has had the non-polar dynamo in his mind. It is a fascinating study, but all the proposals and devices and theories put forward arrive at the same conclusions, that this machine is only a low pressure generator which presents difficulties as great, if not greater, than those in ordinary dynamos, over and above the extremely low pressure difficulty. All attempts at raising the pressure at once lands the designer into the domain of the ordinary dynamo. It is a profitless pursuit, the search after high pressure non-polar dynamos. In its native simplicity, coupled to a steam turbine, there is perhaps some field of application for it in the electrolytic, electro-chemical, electroplating and electrotyping industries; but even in these applications it has yet to be practicably demonstrated. What are its advantages over an ordinary low pressure bar armature dynamo?

The study of the designs for non-polar dynamos is very instructive, and experiments with various arrangements still more so. The results, whether positive or negative, throw side lights on the theory of magnetic induction in moving conductors of much value to the student.

There are two ways of picturing to the mind the mechanical production of current by moving conductors through lines of magnetic force; first, we may say that current is produced by the cutting of the lines by the conductor, or we may say that current is produced in a conductor forming a closed circuit, when by means of the mechanical motion the lines are increased or decreased within the circuit; this last definition is the safest one upon which to theorise.

In the non-polar dynamo the external circuit forms part of the circuit within which the increase or decrease of lines of force must take place to produce the current. The lines are supposed to be like threads, infinitely long and infinitely thin, proceeding from the surface of the magnets, so that on revolving that part of the closed circuit which is within the magnetic circuit, these lines or threads are continually wound on the conductor like thread on a bobbin, thus continually increasing the number of lines enclosed by the circuit and producing a steady current.

But while we consider the non-polar dynamo of great educational interest, we very much doubt if it will ever figure much as a generator in the electric light and power business.

ELECTRIC WAVES.

Prof. Oliver Lodge is a worthy continuator of the epoch-making work of the great Hertz. In his recent lecture at the Royal Institution he showed some interesting electric wave experiments with apparatus of remarkable simplicity and sensitiveness. As he remarked, "the detector for Hertz waves might have been used in the last century; it might have been used by Benjamin Franklin." The instrument which Dr. Lodge has devised for detecting electric waves he calls a coherer. It may be described as an electric welder on a very small scale, the electric welding being effected by the exceedingly minute currents produced at the contact of two pieces of metal by Hertz waves. Lodge had observed, in 1889, that two knobs, so close together that the air gap was unable to stand any such voltage as an electroscope can show, would actually cohere when a spark passed between them. The joint thus welded was capable of conducting an ordinary bell-ringing current if a single voltaic cell was in circuit, and required a perceptible amount of force to separate it. This arrangement has been developed by Lodge into an extremely sensitive electric wave detector. One terminal of an electric circuit, containing a single voltaic cell and a moderately sensitive galvanometer, consists of an iron wire which rests lightly on an iron plate attached to the other terminal. The instrument is most sensitive when the contact is sufficiently good to allow a very small current to pass. If electric waves are produced, say, by charging and discharging an insulated sphere at some distance, the insulating layer at the contact of the coherer breaks down, and a considerable deflection is shown on the galvanometer. With this simple apparatus the reflection, refraction, polarisation, and other optical pro-

perties of electric waves can be readily demonstrated. Electric oscillations in a sphere 60 yards distant have been indicated, and Dr. Lodge estimates that they would be detected half a mile away. The sensitiveness of the contact can be restored by tapping the plate.

On these phenomena Dr. Lodge has founded an ingenious theory of vision. The retina of the eye is supposed to be furnished with cohesive contacts which allow an electric current to flow in the nerves when acted upon by the electromagnetic waves of light. Mechanical vibration supplied by the tissues restores the sensitiveness of the contact at intervals of a tenth of a second. A model has been constructed by Dr. Lodge to illustrate this theory. An electric bell, or other mechanical vibrator, is mounted on the same board as a tube of filings, which in this case acts as a detector, and has its sensitiveness restored by the vibrations of the bell. This apparatus can be arranged so that a feeble electric stimulus produces a feeble, steady effect, and a stronger stimulus a stronger effect.

The coherer is more sensitive to short waves than to long. The sparking at the contacts of an electric gas lighter will produce a marked effect, while heavy sparks from a large influence machine will not affect the instrument. Like the eye, the coherer has a limited range of wave lengths.

This field of investigation promises results of great theoretical interest at least. Whether electric oscillations of these extremely high frequencies are ever to have any technical application is doubtful. The experiments of Tesla and others in this direction have not been promising.

Electricity by Correspondence.

Our American contemporary, *Electrical Engineering*, calls attention to the evils of a scheme for teaching "Practical Electricity" by correspondence. The idea is to follow the same lines as those of the schools already in existence, which instruct, by correspondence, in the mysteries of literature, languages, commerce, stenography, mathematics, and pure science. This, as far as we know, is a consummation to which England has not yet aspired; for while we have, at Cambridge, one of the most successful organisations ever devised for exerting an educational "action at a distance"—a brilliant evidence of the scholastic value of a correspondence college—their curriculum does not include "Practical Electricity" by that name. Our pretty cousin is inclined, upon this occasion, to be censorious, almost dictatorial, in her objections, but we think her frowns are intended for a particular offender, rather than for the whole race of them. If we take a different view of the offence it is partly because we prefer to assign a wider meaning to the term "practical," and partly, again, because we have no specific institution to attack. An eminent scientist, and an acknowledged authority on "technical education," once wrote a whole volume of correspondence on "Practical Electricity," and no one will deny that this book is strictly in accord with its title; for, in so far as it teaches a man to be a better practical electrician, it certainly imparts to him a knowledge of "practical electricity," in its very best sense. Abstract knowledge is such only while it is idle, and to the electrician it is never at rest; to him a theory is something far more serious than a bag of tricks, it is his very practical tool box, without which he is little else than a tinker or another man in the street. "Practical electricity taught by correspondence" is, undoubtedly, open to abuse; it would make a very attractive inscription for the door plate of a suburban school, it is so plausible, so suggestive, so innocent, that young gentlemen might be induced by it to pursue their studies at the price of exorbitant fees paid to ignorant swindlers; and yet this would scarcely be worse than some "practical" schools we know, where electricity is taught absolutely *without* correspondence, either with principle or with fact.

Joseph Henry and the Telegraph.

It is not often that technical literature is enlivened by contributions from lady writers; it is, therefore, with special interest that we read the account of "The electro-magnet: or Joseph Henry's place in the history of the electro-magnet," from the pen of his daughter, Miss Mary A. Henry, in a few recent numbers of the New York *Electrical Engineer*. Prof. Henry seems to have made his *début* in science by demonstrating, to the Albany Academy, the great reduction of temperature in steam of high elasticity when suddenly expanded. The principle upon which his experiments were based was, of course, already old, but this public exhibition of it seems to have had its effect in stimulating invention in the direction of ice-making machines. In 1826 he was appointed Professor of Mathematics and Natural History in the Albany Academy. Henry followed up the results of Oersted, Ampère and Sturgeon, and his first great discovery was a method for improving Sturgeon's electro-magnet, by insulating the wire with silk windings and increasing the number of turns. This, though an apparently small step, was of immense importance at the time, for it encouraged the almost despondent attempts that were then being made in the direction of telegraphy. By *insulating* the wire, he was able to wind on consecutive layers, and thus increase the attractive force so as to make a practicable magnet, in place of the primitive horse-shoe of Sturgeon. Then followed his experiments on telegraphy, against the difficulties of "resistance," and in the face of the old world idea that "the galvanic force was unable to act through any great length of wire." After numerous trials with single elements and plates of various dimensions, he demonstrated that "a mechanical effect could be produced by the galvanic current at a great distance, operating upon a magnet or needle, and that the telegraph was therefore possible." The battery was not his, but he claims to have discovered its latent power, and the way to use it. Henry published the account of these experiments in *Silliman's Journal*, of January 1st, 1831; he does not say positively in that paper whether they were made in 1829 or 1830—but Miss Henry shows reason to believe that it was in August or July of 1829. His experiments on the induction of a wire upon itself were first made public in *Silliman's Journal* for 1832, Vol. xxii. These articles by Miss Henry form a very interesting page in the history of those days when the telegraph was a child. The battle of priority as to the invention of the telegraph, was fought long and fiercely on both sides of the Atlantic. Perhaps the most concise account of England's claims in the matter is that given by the late Sir Charles Bright in his inaugural address to the Society of Telegraph Engineers and Electricians in 1887—an address, by the way, which may be regarded among the classics of electrical literature. He there observes that, prior to the actual realisation of telegraphy, more than 60 claims were already made out for suggestions of various kinds, all directed to that end. Ampère himself proposed, at the suggestion of La Place, that such a system was possible; but its attainment rests upon the united and developed work of such men as Volta, Brewster, Arago, Humboldt, Wollaston, Davy, Oersted, Schweigger, Ohm and Faraday—the fact is, that the electric telegraph was evolved, not discovered. Yet among its projectors the name of Prof. Henry will never be forgotten, for though he can scarcely be regarded—as gracefully hinted by Miss Henry in her articles—as "the father of telegraphy," his name must ever hold a high place in the brotherhood of distinguished men whose unceasing labours brought the telegraph into existence.

INCANDESCENCE LAMPS.

Experiments on their Variations in Consumption and Luminous Power.

We now publish the results of tests taken on a certain number of incandescence lamps with a view to studying in connection with the number of hours of lighting, the variations in luminous intensity and in consumption of energy. The various tests published each year are interesting in that they enable us to follow the progress realised in the lamp industry.

The lamps used in the present instance were by different makers. It not being our object, says M. Gasnier in *L'Industrie Electrique*, to make comparisons between different makers, we will simply distinguish each make of lamp by a letter of the alphabet. Before giving the results obtained we will briefly describe our mode of procedure.

Standard of Light.—The standard chosen was the Carcel lamp burning 42 g. of oil per hour. The regulation of this lamp takes some time and is rather difficult. Moreover, the consumption does not remain constant long, and we are, therefore, compelled to follow its variations by means of the balance. The law of proportionality between the luminous power and the consumption, between 36 and 46 g., is not as a rule exact, and, even if we assume that it is, we have continually to make corrections.

On account of these various reasons, after several experiments, the direct employment of the Carcel lamp was discontinued. Ten good incandescence lamps were taken as secondary standards and measured periodically by means of the Carcel lamp regulated with all the necessary care. These standard lamps were afterwards only brought into requisition during the time required to regulate the position of an incandescence lamp substituted for the Carcel. For this purpose the standard lamp placed on the stand of lamps to be measured was brought to that point of the scale that corresponded to its luminous power. The lamp substituted for the Carcel was then placed in such a manner as to

Conditions of Working of Incandescence Lamps.

Lamps 110 volts—10 candles.

Designation of the set.	Duration of the lighting in hours.	Number of lamps.	Luminous power in decimal candles.	Power consumed in watts.	Specific expenditure in watts per candle.	Duration of working in hours.
1. A.	0	10	11·6	28·51	2·46	...
	150	10	9·6	27·83	2·90	...
	375	10	7·9	26·97	3·42	...
	500	10	7·1	26·47	3·75	...
2. B.	0	9	11·1	28·71	2·60	...
	60	9	9·9	27·50	2·78	...
	150	7	9·6	27·21	2·83	125 and 133
	290	6	8·9	27·06	3·04	225
	480	5	8·1	26·62	3·30	436
	600	5	7·7	26·40	3·41	...
3. C.	0	5	12·6	34·98	2·78	...
	50	5	11·5	35·09	3·05	...
	100	5	10·0	34·98	3·50	...
	200	5	8·6	34·54	3·99	...
	400	5	7·7	33·44	4·32	...
	800	5	6·7	33·00	4·89	...
4. D.	0	6	8·0	22·68	2·83	...
	125	6	7·6	23·26	3·06	...
	225	6	7·1	22·79	3·22	...
	400	6	6·5	22·66	3·48	...
	600	6	5·8	22·14	3·81	...
5. E.	0	8	10·9	31·02	2·84	...
	220	8	10·1	30·47	3·01	...
	450	8	8·4	29·70	3·52	...
	600	8	7·6	29·26	3·85	...
6. D.	0	10	11·8	35·36	3·00	...
	160	9	11·9	35·68	3·00	140
	350	6	10·9	34·60	3·17	168, 288 and 312
	600	2	8·5	33·00	3·88	432, 456, 504 and 576
7. E.	0	8	12·2	37·73	3·08	...
	160	8	12·0	37·62	3·13	...
	350	8	11·8	37·51	3·17	...
	600	8	11·6	37·30	3·22	...
8. F.	0	10	12·2	37·92	3·11	...
	160	10	8·8	36·57	4·08	...
	400	10	8·3	35·74	4·29	...
	600	10	7·6	35·25	4·65	...
9. D.	0	10	9·0	28·16	3·18	...
	160	10	9·9	29·62	3·00	...
	400	10	9·3	29·37	3·16	...
	600	10	8·6	28·71	3·36	...
10. K.	0	10	10·6	36·00	3·40	...
	110	10	10·3	35·83	3·48	...
	365	10	10·3	35·98	3·49	...
	500	10	10·1	35·80	3·54	...
	650	10	9·1	35·70	3·92	...
11. C.	0	4	9·0	31·84	3·54	...
	100	4	9·5	32·83	3·46	...
	350	4	9·4	32·89	3·50	...
	600	4	9·1	32·72	3·60	...

Lamps 110 volts—16 candles.

Designation of the set.	Duration of the lighting in hours.	Number of lamps.	Luminous power in decimal candles.	Power consumed in watts.	Specific expenditure in watts per candle.	Duration of working in hours.
12. C.	0	10	16·2	36·10	2·23	...
	150	10	13·2	34·30	2·60	...
	400	8	8·2	30·66	3·72	363 and 394
13. E.	0	8	18·8	45·60	2·43	...
	100	8	17·9	45·54	2·54	...
	350	8	14·0	43·78	3·12	...
	600	7	12·3	43·45	3·53	469
14. A.	0	8	17·1	42·9	2·51	...
	175	8	14·4	42·1	2·92	...
	375	8	11·8	41·25	3·50	...
	500	8	10·8	40·74	3·76	...
15. C.	0	5	19·1	48·51	2·54	...
	50	5	18·9	49·06	2·60	...
	100	5	17·2	48·73	2·84	...
	200	4	15·0	47·74	3·18	140
	400	3	12·1	44·77	3·70	267
	800	2	10·8	42·57	3·94	659
16. A.	0	8	16·3	44·88	2·76	...
	250	8	14·6	44·77	3·07	...
	450	8	11·8	44·66	3·77	...
	600	8	10·4	44·33	4·29	...
17. D.	0	10	15·3	47·57	3·11	...
	160	10	15·9	48·96	3·08	...
	400	8	14·5	46·76	3·23	210 and 236
	600	4	11·9	44·15	3·71	406, 478, 526 and 590
18. D.	0	6	14·3	45·21	3·16	...
	160	6	15·3	47·63	3·12	...
	350	6	14·6	46·86	3·21	...
	600	6	13·0	45·76	3·60	...
19. C.	0	4	15·9	50·98	3·20	...
	100	4	16·2	51·48	3·17	...
	350	4	15·4	51·37	3·32	...
	600	4	14·8	51·15	3·46	...
20. G.	0	10	16·3	52·80	3·25	...
	170	9	17·4	54·56	3·14	168
	400	9	16·5	54·12	3·28	504 and 524
	600	6	15·4	52·36	3·40	...
21. H.	0	9	14·4	47·74	3·32	...
	200	5	12·4	46·2	3·73	75, 107, 120 and 139
	600	1	10·9	46·2	4·24	382, 468, 568 and 571
22. D.	0	8	20·8	62·46	3·00	...
	160	8	22·0	65·50	2·98	...
	400	7	19·4	64·64	3·33	256
	600	4	16·7	61·93	3·71	508, 532 and 540
23. D.	0	6	20·8	69·85	3·36	...
	200	6	23·1	74·14	3·21	...
	400	6	22·2	73·26	3·30	...
	600	6	20·8	73·37	3·53	...

produce equality in the faces of the photometer. The same operation repeated with other standard lamps fixed a mean position. The two lamps are branched in derivation. The second lamp, which then remained lighted during the whole duration of the tests, was regulated each time in the same way. By this method the standards were rendered constant, and we found in lamps that had not been lighted for an interval of six months or a year exactly the same luminous power.

Photometer.—The photometer was composed of a right-angled prism of soft porcelain. An eye-glass placed according to the bisection of the right-angle of the two faces enabled us to bring about, by shifting the lamp under observation, equal illumination of the two faces.

The Testing of the Lamps.—Each set, composed of lamps taken at random from amongst those of a certain maker, was measured, and half only of the set were put in service and subjected to a constant difference of potential of 110 volts. The other half were used as standards enabling us to refer back at any time to the first test.

The lamps in service were measured at various intervals and some of the standard lamps as well, which enabled us, if there was any occasion, to avail ourselves of the results of the test of a co-efficient intended to make them agree with the first determination. The experiments all relate to lamps of 110 volts, 10 and 16 candles, the specific expenditure of which, expressed in watts per candle varies from 2·2 to 3·5.

The table gives the results of the experiments.

The columns to the left relate to 10-candle lamps, and those on the right to 16-candle lamps. The last two experiments relate to 20-candle lamps. The sets of lamps are classified according to the order of the specific consumption at the commencement and numbered 1 to 23. Each of these tests relates to a certain number of lamps selected at random from at least 200 others.

In the column headed "Number of lamps," we indicate the number of lamps used for the experiment after so many hours lighting. The duration of the lamps that had their filaments broken during the interval between one measurement and another is carried to the last column, "Duration of working in hours," and opposite the corresponding experiment. The experiments were not, as a rule, extended beyond 600 hours. We thought that the study of the variations in the elements of working would not offer any great interest beyond that duration of lighting. For lamps of an initial specific consumption of less than 3 watts per candle, the price of the candle hour is at a minimum which varies with the specific consumption, but is always reckoned within 600 hours of service.

Test 6, when compared with tests 4 and 9, all three relating to 10-candle D lamps, shows what divergencies are to be met with in lamps of the same make, and how little justified we would be in many cases in applying to all lamps of a certain make the results of one single test. Tests 8 F and 21 H which gave bad results, the first as regards luminous power, and the second as regards duration, relate to lamps of foreign make.

ON THE MEASUREMENT OF THE RESISTANCE OF ELECTROLYTES.*

By F. J. A. McKITTRICK, Physical Laboratory, Dalhousie College, Halifax.

DURING the present session at Dalhousie College, I wished to make a series of experiments, determining the electrical resistance of certain electrolytes. Not having the apparatus necessary for Kohlrausch's method at my disposal, I employed that used by Ewing and MacGregor (*Trans.* R. S. Edin., Vol. xxvii. (1873), p. 51), which, according to the tests applied to it by Prof. MacGregor (*Trans.* R. S. Can., Vol. viii. (1890), Sec. 3, p. 49), seemed capable of giving results sufficiently accurate for my purpose.

Since this method, for its most successful application, especially if used in the way suggested by Prof. MacGregor in the latter of these two papers, requires some training of the eye in observing the motions of a spot of light, I undertook a series of preliminary experiments. In the course of these experiments certain improvements suggested themselves to me. These improvements and their effect on the working of the method this paper attempts to point out.

As the above method has been fully described by Prof. MacGregor in the paper already referred to, I need give but a short sketch of it here. The electrolytic conductor is introduced by platinum electrodes as one of the arms of Wheatstone's bridge, and the process of determining its resistance is the same as in the case of a metallic conductor, viz., by a gradual adjustment of the arms. The indications of the galvanometer, however, will not be the same as in that case, owing to the fact that the electrodes become polarised through the passage of the current. The effect of this polarisation on the galvanometer is the same as if, during the passage of the current, the resistance of the electrolytic cell gradually increased.

Imagine the arms of the bridge so adjusted that, on the passage of the current, the light spot of the galvanometer moves off to the right and remains there, such a deflection having been ascertained to mean that the resistance being measured, if metallic, was too small to give zero deflection. If we gradually change the adjustment of the arms in such a way as to diminish this deflection to the right, it will not be found possible to obtain an adjustment making the deflection zero, but an adjustment will be reached with which the light spot moves first to the right, stops, moves back and off to the left, showing that though at the beginning of the flow of the current, the resistance of the cell was small enough to give a deflection to the right, it has been virtually increased by the polarisation until it is so large as to give a deflection to the left. We have thus a double deflection. As we continue changing the adjustment so as to diminish the initial deflection to the right, the double deflection will grow less and less, until finally we shall have only the deflection to the left.

If we had a magnet and mirror of indefinitely small moment of inertia, hung by a fibre offering no resistance to torsion, so that it would, at any instant, indicate the direction of the current flowing through it, this double deflection would only just vanish when the adjustment of the arms indicated the exact resistance of the cell, *i.e.*, when the resistance of the cell, calculated in the ordinary way from the resistances in the other arms, would be its exact resistance.

With an actual mirror and magnet of finite moment of inertia, no appreciable motion can be observed till the current has acted for some time. If the adjustment of the arms be such as to indicate a resistance for the cell only slightly greater than its real value, the first current flowing through the galvanometer will be very weak, and, before it will have had time to produce an appreciable deflection of the mirror, the electrodes will have become polarised, and our only deflection will be one to the left. If, then, we take the resistance of the cell to be that indicated when the double deflection has just vanished, we make an error, and conclude the resistance to be greater than it really is. Whether, with any magnet and mirror yet manufactured, this error can be made small enough to be neglected, can be determined only by experiment.

In their experiments, Ewing and MacGregor assumed that the light mirror and magnets of Lord Kelvin's dead-beat galvanometer would give a close approximation to accurate results. In order to reduce polarisation they used as current generator only one Grove cell, and introduced large resistances into the arms of the bridge. Their determinations, however, when compared with those given by more elaborate and accurate methods, were found to be too large, differing from Kohlrausch's, in some cases, by as much as 12 per cent.

As their experiments were made when they were students and had acquired little experience in experimental work, the discrepancy may have been due to other causes than the defects of the method. Hence Prof. MacGregor, in order to test the method, made a series of experiments, described in the paper cited above, comparing the resistances of solutions of zinc sulphate as given by this method and by the use of non-polarisable electrodes. To reduce polarisation, he also used weak currents, and, in addition, electrodes of large area. He found that if the mere vanishing of the double deflection

* *Transactions* of the Nova Scotian Institute of Science, Ser. 2, Vol. 1.

were taken as the test of adjustment, the resistances determined would be too much greater than their real values to be regarded as a sufficiently close approximation. He noticed, however, that when he could no longer observe a double deflection, he yet could notice a distinct hesitation at the beginning of the single deflection. That this should be so is evident. For, after the double deflection has just vanished, the first current passing through the galvanometer still tends to cause a deflection to the right, but is overpowered by the polarisation current. Hence the mirror does not begin to move as soon as contact is made, but for a short time remains at rest. Clearly, then, if the adjustment of the arms be changed until we can observe not only no double deflection, but also no hesitation, we shall get more nearly accurate results. By observing the vanishing of the hesitation, Prof. MacGregor was able to get results which, in the case of high resistances, differed from their true values only by from 0·1 to 0·4 per cent.

I began, therefore, by endeavouring to observe the vanishing of this hesitation, testing my results in the same way as Prof. MacGregor had done in the paper cited above.

The electrolytic cell which I used consisted of strips of window glass cemented together with marine glue. Its length was about 16 cm., breadth, 8 cm.; depth, 9 cm. It was divided transversely into two equal compartments by a glass partition, cemented in so as to be water-tight. Passing through the centre of this partition, and cemented at right angles to it, was a glass tube with its ends open. Its length was 1 cm., the diameter of its bore 0·3 cm. At each end of the box I placed my platinum or amalgamated zinc electrodes, as the case might be. They were each about 7 cm. square, and had narrow strips projecting above the box. To these strips of the zinc electrodes thick copper wires had been soldered without the use of acid; to the platinum electrodes thick platinum wires had been welded. By these wires the cell could be joined up as an arm of the bridge.

The electrodes were in all cases placed as close as possible to the ends of the box. Since, however, the resistance of the column of liquid in the tube was about 1,000 times that of a cross-section 1 cm. in length of the liquid in the box, slight differences in placing the electrodes made no appreciable difference in the resistance of the box.

The part of the box above the surface of the liquid (especially that of the glass partition) was kept clean and dry, and, during the experiments, except where the narrow strips of the electrodes projected upwards, the box was kept covered.

With this cell (1) it was the same liquid, whose resistance was measured whether the platinum or zinc electrodes were used, and (2) the tube being in the centre of a large mass of liquid, that liquid being approximately at the temperature of the laboratory, and the time intervening between two measurements, one by platinum, the other by zinc electrodes, being small, any change in the resistance due to change in temperature might be neglected.

The box of resistance coils used was a small one. The coils were arranged so as to form three arms of a Wheatstone's bridge. Two of them contained two coils each, 10 and 100 Siemens units respectively. The third contained a number of coils, ranging from 500 to 1 Siemens units, together with a rheochord for measuring fractions of a unit. The coils had been accurately calibrated in legal ohms by White, of Glasgow.

The galvanometer used was a "dead beat" one of Lord Kelvin's, having a resistance of 400 ohms. The mirror, with magnets attached, weighed 0·035 grms.

For making and breaking contact I used a "rocker," so designed, that the battery wire was joined up a small fraction of a second before that of the galvanometer.

I found that I was unable with any certainty to detect the vanishing of the hesitation. To my eye it did not seem to vanish even when the adjustment of the arms indicated less than the actual resistance of the cell. The motions of the magnet certainly became quicker then, but none the less did I think I could detect a hesitation. Nor is this other than we would expect. The current must always act for a certain time before any appreciable motion of the mirror occurs. The length of this time will vary with the strength of the current. With a weak current the magnet always starts slowly, while with a strong current it may seem to start almost instantaneously. With a certain current and a certain resistance of our cell, there will be a particular hesitation corresponding to the adjustment of the arms indicating the exact resistance of the cell. With considerable practice we may train the eye to recognise this particular hesitation, so that, within a short range of this resistance of the cell, we may be able to make almost perfect measurements. This was the only way in which I was able to use Professor MacGregor's method, and the result was unsatisfactory. For when the resistance of the cell was changed to any extent, the strength of the current changed, and I found that my familiar hesitation was no longer that which corresponded to the adjustment of the arms indicating the resistance of the cell.

In my experiments I noticed, however, what is clearly evident, that the stronger the currents, the greater was my double deflection, that if, for certain resistances of the arms, with a certain current I could get a double deflection, then with a stronger current I would get a larger deflection, and what to me was more important, if, in the former case the double deflection had just vanished, in the latter case it was distinctly visible. I immediately tried still stronger currents, and found that in every case the stronger the current the nearer would the adjustment of the arms, when the double deflection had just vanished, indicate the true resistance of the cell. It appeared, therefore, that I had merely to increase the strength of the current to make my error as small as I pleased.

In attempting this, however, difficulties arose:

1. As the battery current was increased, so was the polarisation current. To lessen this my electrodes were made as large as possible. As I have stated above, they were about 7 cm. square. I might have platinised them, after the manner of Kohlrausch; but as the method under consideration, owing to the simplicity of apparatus required, is especially useful for measuring resistances of electrolytes in ordinary laboratory work, I was more interested in knowing what degree of accuracy was attainable by it with apparatus which is always at hand.

2. Since the motions of the mirror are indicated by those of the spot of light reflected from it to a screen, in proportion as the double deflection gets smaller and smaller, the difficulty in observing it gets greater and greater. Especially is this so if the current be strong, for then the motions of the spot become so rapid that, unless the double deflection is distinctly made, we are not able to observe it. This difficulty I completely removed by placing a rectangular sheet of zinc 3 or 4 inches in front of, and hiding from my eye, the left side of the screen. It was easy to place this so that, on looking past its right edge, I could just see the faintest glimmer of the spot of light. Since I always sent the current in such a direction that the double deflection was to the right, it is evident that even the least tremble of the spot to the light could be at once observed. More especially was this so, as the sheet of zinc was much nearer to the spot of light than to my eye. It is necessary, of course, that the edge of the spot of light that we are observing should be very clearly defined, and that no motion of the head should be made at the instant of observation.

3. With strong currents, electrolysis of the solution goes on at a rapid rate, and, again, there is danger of the coils becoming heated. During the final measurements, then, when we are using the strongest currents, contact in the battery wire must last only for a small fraction of a second. The "rocker," thus, became too slow a means of making and breaking contact. By joining up the galvanometer first and by a separate key (a method to be justified later), the solution of this difficulty became easy, for then we have only to make and break contact rapidly in the one wire. This I accomplished by slightly flattening a piece of thick copper wire, and sinking it into a board till its flattened surface was only slightly above that of the board. This wire I connected with one of the battery wires. The end of the other battery wire I flattened, and by simply drawing it over the board and across the wire, contact could be made and broken as rapidly as desired.

I found it quite impossible, as did Ewing and MacGregor, and Prof. MacGregor, to obtain platinum electrodes which, in themselves, did not constitute a voltaic cell. In every case my electrolytic cell was found to be a voltaic cell with a small, and, apart from polarisation, practically constant E.M.F. It is evident that, with this method, the adjustment

of the arms which would give no double deflection would not be exactly the same as if the electrolytic cell were not behaving as a voltaic cell.

Both Ewing and MacGregor, and Prof. MacGregor overcame this difficulty in this way: call e the E.M.F. of the cell. Pass a current through the cell in such a direction as to produce a polarisation current greater than, and opposite in direction to, that produced by e. Then, as this polarisation slowly dies away, there will be a short time during which it will neutralise e. During that time they considered that the test could be made without error due to e.

To this procedure there are objections. In order to produce the necessary polarisation so that it will die away slowly, the current must pass for a certain time, and thus a certain amount of electrolysis goes on—the more, the stronger the current. Then there is the great difficulty in making the test at the instant at which e is exactly neutralised. In my very many trials, I am not certain that I succeeded in making one test with which I was perfectly satisfied. In any case we do not entirely eliminate error due to e. For we have neutralised e only by covering our electrodes with gas, which must make the resistance of our cell appear greater than it really is. Since, however, e can always be made very small, this error is, in practice, negligible.

In his paper, Prof. MacGregor pointed out one result of which he made no use, but which suggested to me an easier solution of this difficulty. What he showed was, in effect, that if the galvanometer wire be joined up first and the spot of light be allowed to take up a new position due to e, and if the adjustment of the arms corresponds to the exact resistance of the cell, then, on making contact in the battery wire, the current through the galvanometer due to e will remain unaltered. It seems reasonable to suppose, therefore, that, if the adjustment of the arms nearly corresponds to the exact resistance of the cell, and if e be very small, then, under these circumstances, any change in the current due to e flowing through the galvanometer, which occurs when contact is made in the battery wire, will be very small. If then we should join up the galvanometer wire first and make our measurements as if e had the value zero, would the error be negligible?

To test this, I simply made several measurements, first by this method, and then by neutralising e. I varied both the size and the direction of e, but in no case was I able to notice any difference in the two measurements.

To proceed in this way, however, the galvanometer must be joined up first. Rigorously, this will not give accurate results; for the principle on which measurement of resistances by Wheatstone's bridge rests requires that the current shall have attained a steady value. Whether, practically, with circuits such as I was using any error would be introduced by this method, could be decided only by experiment. To test this, I simply measured the resistance of a solution of zinc sulphate, using amalgamated zinc electrodes, first joining up the battery wire before the galvanometer wire, and then *vice versâ*. The experiments that I made perfectly satisfied me that the error, if there was one at all, was clearly negligible.

During my experiments the resistance of my cell varied from 100 to 10,000 legal ohms. The accuracy with which I could determine the resistance is shown in the following table, which gives a few average results:—

No. of Grove's cells used.	Resistance as determined by		Error.
	Amal. zn. electrodes.	Pt. electrodes.	
			Per cent.
1	6,360 legal ohms.	6,430 legal ohms.	1·1
2	6,360 "	6,420 "	·94
3	6,360 "	6,407 "	·74
8 of low internal resistance.	177·3 legal ohms.	178·2 legal ohms.	·51
	634·9 "	637·8 "	·46
	1,893 "	1,900 "	·37
"	4,585 "	4,595 "	·22
"	7,439 "	7,450 "	·15
"	9,139 "	9,151 "	·13

As stated above, Prof. MacGregor's error in the measurements of high resistances varied from 0·1 to 0·4 per cent. With low resistances, however, his error was as great as 6 or 7 per cent. The first three entries of the above table show, then, that with a comparatively weak battery as current generator, the errors in the resistances determined by employing the vanishing of the double deflection as test of adjustment, are comparatively large, considerably larger than they would be according to Prof. MacGregor's experience, if the vanishing of the hesitation were taken as the test. The last seven show that with a strong current the employment of the vanishing of the double deflection as test of adjustment gives results which, in the case of high resistances, are considerably more accurate, and in the case of low resistances very much more accurate than those given by a weak battery with the vanishing of the hesitation as test.

It would thus appear that the above modifications render this method capable of measuring all resistances with increased accuracy and low resistances with greatly increased accuracy, while they render it also capable of application without any previous training of the eye, and diminish very materially the time required for its application. The error in the measurement of high resistances is still greater than that of Kohlrausch's method, viz., 0·05 per cent. The only mirror, however, which was available for my experiments, though it weighed but 0·035 grms., was much heavier than some which, I believe, are now manufactured. With a lighter mirror the inevitable error would doubtless be still further diminished.

COST OF ELECTRICAL ENERGY.

By W. H. BOOTH.

III.

In my article on this subject (Electrical Review, May 11th, 1894), I referred briefly to the results of the Wigan coal trials as showing the fallacy of the impression prevailing in some quarters that the hydrogens of bituminous coals cannot be utilised in steam generation. It should be added that the results there given included a Green's economiser of 84 pipes. Under steam at a pressure of 40 lbs. in the same boiler without economiser, the evaporation was 8·54 lbs. from 100°, which is equivalent to 9·73 lbs. from and at 212°. The trials at Wigan were brought to a close with three general field days, to afford steam users an opportunity of seeing the results obtained. All the boilers were in full work, and they were of marine multitubular type, patent conical water-tube, and two ordinary Lancashire, one with steel and one with iron tubes, and all were fired under different conditions; one with Vicars self-feeding fire grate, and the others by hand. Slack coal was used in two of the boilers, including that fitted with the mechanical grate, and the grate lengths of the two Lancashire boilers were 6 feet and 4 feet respectively. All were heavily fired, and there was no smoke from any of them beyond a slight trace of faint colour now and then. The object of the extended trials was to determine the best mode of firing and the best thickness of fires. Three systems of firing were tried:—(1) spreading; (2) coking; (3) alternate side firing as introduced by Wye Williams. With round coal the highest duty was secured by the coking method, and also the least amount of smoke was made; but with slack coal side firing seemed to have the advantage. The thicknesses tried were 6 inches, 9 inches, and 12 inches, the latter being the limit the furnace diameter would allow, and it was found that the 9-inch fires gave better results than the 6-inch fires, and the 12-inch better than the 9-inch. Similarly, a length of 4 feet gave a more economical result than a length of 6 feet, but was not so powerful. In testing the merits of the different boilers, the fires were all of the standard 12 inches thickness. Without the feed heater the 4 feet grate evaporated nearly 10 lbs. of water and produced 150 horse-power, whilst the 6 feet grate evaporated 9¼ lbs. and produced 170 horse-power—or rather, we should say, units—as the horse-power is defined at 30 lbs. of water per hour. A curious result was found when the boilers were worked without the external flues. The economy was less, but the total evaporation was nearly as great without the external flues as with them.

In the trials made with the marine boiler, it is interesting to observe that whereas at the beginning of the trials a rate

of only 8 lbs. of evaporative duty was secured and 35·88 cubic feet of water per hour, with a consumption of 20 lbs. of coal per foot of grate, the subsequent trials gave an evaporation rate of over 11 lbs., a speed of fully 46 cubic feet per hour, and a coal consumption of 25 lbs. per square foot, simply by attention to the treatment of the fires and slight modifications in the furnace, including a shortening of the grate from 4 feet to 3 feet, a slight lowering of it to give more space above it, and a blank instead of a perforated dead plate. Similarly, by adding a hanging bridge, economy was increased at a slight expense of power, but with a gain in smokelessness. Smokelessness, generally, was secured by the use of air openings in the fire doors, and it would appear that the area of these should be from 1½ to 2 square inches per square foot of grate. The air inlets were, of course, only kept open for the necessary period after each fresh charge.

In testing various thicknesses of fires, the following were the mean results secured:—

Character of test.	Evaporation from 100° at 212°.	Cubic feet evaporated per hour.	Pounds of coal burned per square foot per hour.	Smoke per hour.		
				Light.	Brown.	Black.
Fires 14 inches thick	10·35	47·22	27	2·4	0	0
„ 12 „	10·06	45·67	27	2·8	0	0
„ 9 „	9·65	44·00	27	1·0	0	0

To show how coking compared with spreading, the following abstract of a series of trials may be given:—

Character of test.	Evaporation from 100° at 212°.	Cubic feet evaporated per hour.	Pounds of coal burned per square foot per hour.	Smoke per hour.		
				Light.	Brown.	Black.
Coking fires 12 inches thick, door perforations open after charging...	10·13	46·35	27	3·2	0	0
Ditto, perforations always closed ...	9·75	47·03	29	12·6	1·4	0·6
Spreading ditto, perforations open after charging...	9·51	51·37	32	20·8	5·3	4·2

This showed the economy of smokelessness, but also some loss of speed, which is apt to induce firemen to produce smoke when a boiler is being heavily tasked, though, in this connection, it is to be noted that for the best duty a fireman is always very particular to keep the grate fully covered with fire. This last table shows very strongly the necessity for air admission, and also the advantage of a coking system.

The lessons indicated by these tables, which are a very brief summary of a long series of repeated tests under the various conditions, are chiefly, we think, that thick fires promote economy, and so, also, do short fire grates.

In a fire, even 12 inches thick, the process of combustion soon produces caves and hollow places through which it is easier for air to pass than through other less burned portions.

Thin fires of 4 and 6 inches very quickly burn into holes, and become wasteful, simply because of the large amount of useless air admitted. In the Wigan tests it was found possible, by lowering the grate in the marine boiler, to secure fires 14 inches thick, and the benefits arising from thick fires may have something to do with the superior efficiency of large as compared with small Lancashire boilers, the larger furnace diameter admitting of deeper fires. This leads to the conclusion that for boilers of small size the Cornish boiler is to be preferred to the Lancashire, for in a 6 feet shell the Cornish furnace is as large as the furnaces in a Lancashire boiler of 7½ diameter.

A fire really ought to be of such thickness that all the air which passes through the grate is more or less combined with carbon as regards its oxygen as it issues on the fire surface. The fire is thus a gas producer, to some extent, and the gases are to be burned by the fresh air admitted above the fire. With a good draught this is possible, and in the locomotive we see the effect of a heavy draught and a very thick fire indeed in producing smokeless combustion when air is admitted at the door by the baffle plate. In the locomotive there is also the consolidating effect on the fire of the ordinary shocks and vibrations of the running on a more or less uneven rail. This fills up any cavities produced by the fierce blast, and is a large factor in the economy of the locomotive.

Beyond the question of holes in the fire, we do not see any specially good reason for the superiority of short grates over long ones; but there are few firemen who can attend to and keep in order a fire 6 feet in length; nor does it seem possible for long grates to be worked economically even by mechanical stokers, and, as a rule, therefore, mechanical stokers are found to have short grates.

Reporting on the Wigan trials, Mr. Fletcher, of the Manchester Steam Users Association, wrote:—"We have evaporated as much as 10½ lbs. of water from 100° per lb. of coal upon a grate 4 feet in length and 10¼ lbs. on a grate 6 feet in length. In both cases this has been done without smoke, and while evaporating as much as 100 cubic feet of water per hour in the case of the 6 feet grates, and 80 cubic feet with the 4 feet grates." The diameter of the boiler was 7 feet, so that the horse-power, with a good compound engine, should be 417 and 333 respectively.

Such are briefly a few of the figures from the Wigan tests, and seeing that the opening of the Manchester Ship Canal places London in direct communication by sea with the Wigan coalfield, the products of which can now be shipped direct in the Partington Basin, no apology is needed for presenting these facts relating to what is really a new fuel in the South of England.

The Wigan coals have the reputation in Lancashire of being exeedingly swift to ignite and burn. They are low in sulphur. Being swift they may be burned at a high rate per square foot of grate surface, and the evidence of the Wigan tests as to the superiority of thick fires is specially to be noted in all swift coals, owing to the rapidity with which thin places will develop in the fires. Since this series was commenced, the discussion upon the paper which provoked this was carried on further, and what we have said has been fully corroborated by so sound an authority as Prof. Unwin, who has obtained an evaporative duty from Cornish boilers of 11·87 lbs. without feed heaters, while certain tests of Prof. Kennedy's with marine boilers showed an evaporation of over 10 lbs. in three cases only, and two of these were with north country coals, and one with Welsh, and there was no appreciable difference between them. From the evidence that has been brought forward it appears certain that Mr. Crompton has, perhaps unwittingly, fitted his opinions to his wishes in narrowing down steam plant to a single uniform standard. A certain uniformity is desirable, but when it is carried to the length of sacrificing every local and particular advantage that ought to be utilised, it is certainly too dearly purchased, when after all the standardising of equipment implies at the same time an entire destruction of the possibility of buying fuel in the widest market, a consummation which will certainly tell heavily against economy in the cost of electrical energy.

THE ELECTRIC STATION OF THE CITIZENS' LIGHT AND POWER COMPANY OF ROCHESTER, N.Y.*

By ROBERT CARTWRIGHT, M.Am.Soc.C.E.

(*Concluded from page* 656.)

A horizontal "Woodbury" compound, condensing slide-valve engine with extra heavy bed plate, is set in the power-room at point marked in fig. 8 "Engine No. 1." Steam cylinders are placed with the large cylinder outside, so that pistons and rod may be easily removed. Cylinders are 19 inches, and 31 × 24-inch stroke. At 167 revolutions, with a boiler pressure of 110 lbs. per square inch, vacuum

* Read March 7th, 1894, before the American Society of Civil Engineers.

22 to 24 inches, and cutting off at $\frac{5}{16}$ stroke, the engine is rated at 500 H.P., and is guaranteed to produce a horse-power on an evaporation of 20 lbs. of water per hour. The crank shaft is a steel forging in one piece. Journals are $11\frac{1}{2}$ inches diameter by 21 inches long. Crank pin, $11\frac{1}{2}$ inches diameter by $8\frac{1}{4}$ inches long. The end carrying the rope driving wheel has an outboard bearing. Governor balance wheel is $8\frac{1}{2}$ feet diameter by 25 inches face. Rope driving wheel in halves and 10 feet 6 inches diameter and grooved for 15 $1\frac{3}{8}$-inch ropes. These ropes lead to a 5-feet rope wheel on the line shaft above, with same arrangement for tightener as is applied to the water-wheels.

Fig. 10 is a section of rope driving wheel rim, and gives angle of grooves, pitch and sizes as shown. Rope speed of engine drive is 5,500 feet per minute.

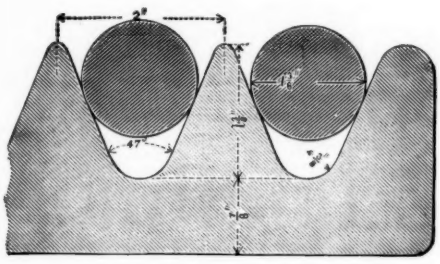


FIG. 10.

The condenser applied is H. W. Bulkley's jet condenser and heater combined. It is shown in position on fig. 3. The injection water is taken from the horizontal portion of the flume, and is supplied under a pressure of 22 lbs. per square inch. The vacuum maintained is 27 to 28 inches. In its performance it is very satisfactory. A strainer box, A, fig. 3, is placed in the supply pipe and contains a copper wire strainer of $\frac{3}{16}$-inch mesh, that is arranged to be quickly removed and replaced by a clean one. The strainer is for the purpose of catching any floating matter that might clog the injection jet, and prevent the condensation. An automatic valve, B, is placed above the condenser, so that the engine can operate non-condensing.

The boiler room and boilers, H, are shown on fig. 2. The house is designed for 10 200-H.P. boilers, only five of which are now in place, space being left for the other five when needed. They are set in one battery. Boilers are horizontal-tubular, set in brickwork. Each boiler is 66 inches in diameter and contains 72 $3\frac{1}{2}$-inch tubes, 18 feet long. The shell is made of three plates, each long enough to reach entirely around without piercing. All the longitudinal seams are placed so as to be above the reach of the fire. Shell plates are $\frac{13}{32}$-inch thick, and all edges planed for calking. All rivet holes are drilled, and any variation of holes was corrected by reaming, no drift pins being used for that purpose. Heads are $\frac{1}{2}$ inch thick and flanged with an internal radius of $1\frac{1}{2}$ inches. Tube holes in heads were drilled and chamfered on both sides. Tubes are American lap-welded, of charcoal iron, set with expander and beaded over on the outside. The horizontal seams are butt seams, with a plate on the outside $9\frac{3}{4}$ inches wide and one on the inside 15 inches wide, with triple rows of rivets each side of the joint; all proportioned to the standard of the Hartford Steam Boiler Inspection and Insurance Company. Each head is stayed to shell with solid crowfoot stays of 1 inch square iron, equal in quality to Burden's best iron. Each boiler has a steam drum 33 inches in diameter by 38 inches high, and is supported in brick work by four lugs near the front end and four near the rear end. The rear lugs rest on iron rollers 1 inch in diameter on suitable plates set in the brick-work. Front lugs are built solid in the brick. Calking is the Connery system. The boilers are intended for a pressure of 110 lbs., and were proved with a hot water pressure of 180 lbs. per square inch. The feed water enters the boilers through the front head above the tubes, and is distributed in the boiler through a perforated $2\frac{1}{2}$-inch pipe. Each boiler is equipped with water column and gauges, pop safety valve, asbestos-lined blow-off cock, and all the necessary water-stop and check valves, so that the boilers may be used independently, or as one battery. Each boiler has two manholes, one on top and one in the front head below the tubes. All the material in the plates and heads is Park Bros. open-hearth, homogeneous flange steel, with a tensile strength guaranteed between the limits of 55,000 to 62,000 lbs. per square inch of section, and limit of elasticity between 35,000 and 40,000 lbs. per square inch. The boilers are supplied with water by a duplex Worthington pump, with 9-inch steam cylinder, $5\frac{1}{4}$-inch water cylinder by 10-inch stroke, taking the water from the flume through a strainer box. The boiler house is paved with hard brick, laid herring-bone on edge, grouted with cement mortar, and bedded on 8 inches of concrete. The smoke jack is of No. 10 iron, built on a skeleton frame of $2\frac{1}{2}$ by 3 by $\frac{5}{16}$-inch angles. A damper is arranged from each boiler in smoke jack. As shown, it

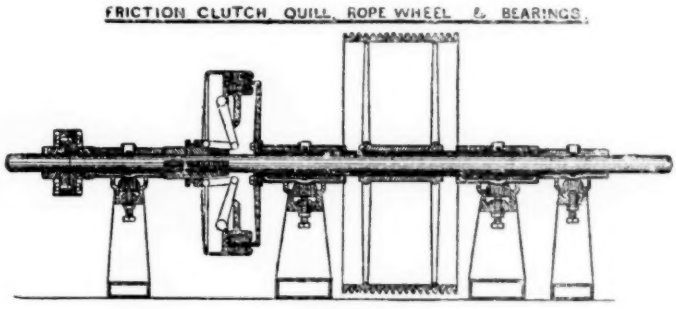


FIG. 12.

is graduated in size, being 5 by 10 feet at the chimney end. It was painted with two coats of asphalt paint inside and out.

Fig. 11 shows plan of line-shaft floor. Shafts are of

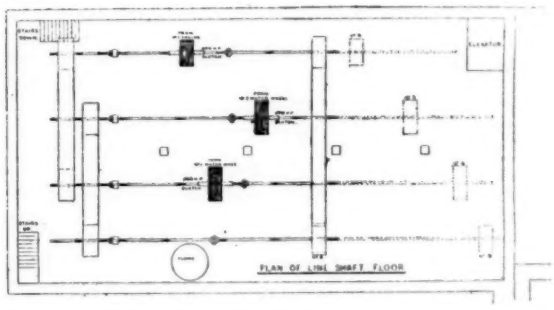


FIG. 11.

hammered iron 5 inches in diameter, and arranged with heavy floor pedestals, fitted with self-adjusting, ring-oiled, babbet-lined bearings. The rope wheels are placed on heavy cast-iron quills, furnished with Hill friction clutches of 500 H.P. capacity each. By a series of jaw clutches, pulleys and belts, any line shaft can be operated from any water-wheel or engine, all the line shafts making the same number of revolutions.

Fig. 12 shows in detail, the quill, clutch, and bearings. The floors of the line-shaft and dynamo rooms are made of steel I beams, built and anchored into the walls at outside ends, and attached in the centre to longitudinal girders of heavy steel I beams. Girders are supported on columns formed of channel beams and lattice bracing. Columns rest on cap-stoned masonry carried down to the rock.

The wooden floors are made of 2 × 6-inch hemlock plank, matched and surfaced and spiked to fitting strips under flange of I beams. Upon this, and laid at right angles to the hemlock, is nailed $1\frac{1}{8}$ × 4-inch matched, seasoned hard maple.

All of the stone used in the work was quarried stone, as the rock cut out was a shale that disintegrated on exposure, and was fit for nothing but filling.

The brick was hard-burned sewer brick, wetted as it was laid.

The cement used was the Columbia brand of American Portland. The result of five tests of this cement, made by

O. H. Peacock, Esq., engineer of the East Side Sewer Commission, of Rochester, N.Y., is appended.

Briquette made.	Put in water.	Broken.	Tensile strength per square inch.	Time of immersion.
			Pounds.	
1. Aug. 24th, 1892, 3 p.m.	3.30 p.m.	Aug. 25th, 1892, 3.30 p.m.	225	24 hours.
2. Aug. 24th, 1892, 3 p.m.	3.30 p.m.	Aug. 25th, 1892, 3.30 p.m.	255	,,
3. Sept. 12th, 1892, 10.25 a.m.	10.55 a.m.	Sept. 13th, 1892, 11.30 a.m.	210	,,
4. July 19th, 1893, 10.10 a.m.	11 a.m.	July 26th, 1893, 11 a.m.	446	7 days.
5. Aug. 21st, 1893, 3 p.m.	3.30 p.m.	Aug. 28th, 1893, 3 p.m.	535	,,

All of the rock cutting, excavating, and stone and brickwork was performed by the firm of Chambers & Casey, of Rochester, N.Y., they also furnishing all the materials and tools to complete the buildings.

The water-wheels were built and erected by the firm of Robt. Poole & Son Company, of Baltimore, M.D.

The engine and boilers were from the Stearns Mfg. Co., of Erie, Pa.

The steel floors, roofs and flume were furnished by the Rochester Bridge Works, of John F. Alden.

Line-shafting bearings, friction clutches and pulleys, were supplied by the Hill Clutch Company, of Cleveland, O.

The carpenter work was performed by R. Williamson; the windows, doors, and frames were from the Ocorr & Rugg Company; the smoke jack and slush pipe and roof covering were furnished by the John Siddons Company; the steam piping, pumps, and plumbing by Barr & Creelman, all of Rochester, N.Y.

DISCUSSION.

William P. Craighill, Prest. Am.Soc.C.E.: I did not expect to say a word concerning the interesting paper presented by our friend Mr. Cartwright, but, before the discussion begins, I will take the liberty of emphasising several points he has made. One is the great care which should be taken in the construction of brick masonry in order to insure good results. Two cases may be mentioned which were a part of my experience more than 40 years ago. They are of a special and unusual character. I refer to Fort Pulaski, on the Savannah River, and to Fort Sumter, in Charleston Harbour. These forts were then unfinished. Later, in the Civil War, much of their masonry was greatly broken to pieces by the guns of General Gillmore. After the war, when repairs and reconstruction began, the importance was very clearly shown of the truth of one of Mr. Cartwright's cautions, viz., the necessity, in order to have the best brick masonry, of great care in seeing every brick carefully soaked in water before being laid. It is not enough to have the bricks simply damp. They should be soaked so as to be dripping when laid. And, to this end, every mason should have his barrel or tub of water near him in which his bricks may be soaked before being used, and an inspector should be around to see it properly attended to. The result proved again the importance of this precaution, for in the masses of masonry at Forts Pulaski and Sumter, broken up under those peculiar circumstances, it was found that the adhesion of the mortar to the brick was greater than the cohesion of the particles of the brick among themselves. I recollect well how this watering of the bricks was insisted on by my then chief, General Totten, in his detailed instructions to his young subordinates. The farther south I went, as, for instance, at the Dry Tortugas, in the Gulf of Mexico, the more stress was laid upon it. There is another point to which Mr. Cartwright referred, the use of salt in masonry in freezing weather. This may be of great value in special cases. Take, for instance, one like the Great Kanawha River, where, in building locks and dams, much of the work must be done in coffer dams. The Kanawha is a very uncertain, inconstant stream. The freshets come often and unexpectedly, and sometimes very high. To keep them out would require coffers of very great height with proportionate expense and inconvenience of use at lower stages. Advantage should therefore be taken of every hour when the coffers are not flooded, to expedite the work. The masonry on the Kanawha is of stone and concrete. There is one more point to which I will refer, the danger of too much dependence on mathematical formulas. Our education as engineers leads us, and very properly too, to value our mathematics and formulas most highly, and the man who undervalues them, or tries to dispense with them, is a very unwise one. But we should avoid both extremes, and this is a safe rule in almost all departments of life. In hydraulic work of the special kind to which most of my attention has been given for many years past, the improvement of rivers and harbours, there are so many conditions to be taken into account, which are very variable, even from hour to hour, and so many of which we know little, and about which we must accept mere theories, that the formulas must be used with great care in order to avoid serious mistakes. Even when we are applying formulas to cases like masonry, bridges, &c., where the materials are few and well known and we have varied experiences, we find it necessary to have large factors of safety. I will not detain the Society longer from the discussion of Mr. Cartwright's interesting paper, and we will now be glad to hear any one who may wish to speak on the subject.

H. W. Brinckerhoff, M.Am.Soc.C.E.: I would like to ask Mr. Cartwright how he got along with his masons with the use of very wet bricks? The masons, I know, complain that very wet bricks soften their fingers.

Bernard R. Green, M.Am.Soc.C.E.: Having, unfortunately, but just come in, I did not hear the paper read, and perhaps am out of order; but I do not understand why the bricklayers' hands should have been so much injured in laying wetted bricks in cement mortar. I have laid many millions of bricks in that way and never observed serious results of that kind. The bricklayer does not necessarily put his hands into the mortar. He handles the clean, wet brick with one hand and the mortar with the trowel in the other. The bricks should be well dampened, but not soaked. The experience referred to, however, by the author may have been in some other sort of work than I have supposed.

Charles E. Emery, M.Am.Soc.C.E.: I had intended to say but a few words. The paper, to a certain extent, explains itself so entirely that there is little opportunity for discussion. I have seen one of Mr. Cartwright's plants in operation at Rochester in which rope transmission is used, and it operated very perfectly, and was a very satisfactory piece of work. The very thorough way in which Mr. Cartwright does his work is to be commended, and I am sure we must feel very grateful to him for the careful manner in which he has presented an example here. Referring to the criticism of formulas brought out in the discussion, I will say that the fault of some formulas is that they are not correctly founded on facts, or are incorrect in form. A correct formula, with correct constants, based on careful experiments, will always give correct results. The difficulty is that the mathematicians and physicists do not always take proper pains to obtain correct constants, while practical men who attempt to formulate experimental results frequently attempt to construct the formula too simply, so that it is little more than the rule of three, and thereby make it inapplicable, except for conditions closely approximating the experimental ones. I have never had any difficulty in solving questions in regard to expansion by simple calculations. Such calculations frequently require the combination of rules relating to linear expansion with those for the transverse strength of girders, but the method is evident; there should be no difficulty in ascertaining just how much pipes can be permitted to bend before becoming over-strained. It was only a few days ago that an engine-builder asked my advice about connecting the horizontal cylinders of a cross compound engine rigidly, by means of piping under the floor. They had been accustomed to make such connections in the smaller engines, but in this case the superintending engineer objected. Simple calculations showed that if it were possible to hold the two engine foundations rigidly in position, the compression would not be beyond the limit of elasticity of the metal of the pipes, even if the whole expansion were taken up in that way; but there would be great strain on the joints, which might become leaky when the pipes were cooled. Even if metallic joints were used the compressive strain caused by the temperature would amount to very many thousand pounds per square inch, based on well-known facts as to the rate of expansion and the modulus of elasticity, and I called the attention of my client to the fact that the separate foundations were not laterally sufficiently rigid to resist those strains, but that the weaker side would be pushed

over slightly, thus throwing the engine out of line. As this was a sensitive point, and as it was desired that the engines should, above everything, work smoothly and continuously, it settled the question, and on looking over the connections it was found that the pipes could be very easily crooked and thus provide for expansion without an expansion joint. Mr. Cartwright studies his work so carefully and adapts means to ends in so thorough a way that I regret no figures as to costs are given. This is an important omission. Some of us are making special studies on the general subject from an economic basis, in which are considered, not simply the coal consumed, the amount of labour employed and the cost of repairs, but the first cost of the plant as a whole, for the reason that the interest thereon, which is an annual expense, may under certain conditions be so great that an apparatus cheaper than another may, when all expenses are considered on an economic basis, be the best adapted for the work. I will be pleased to hear from Mr. Cartwright the cost of his building, wheel pits, head and tail races, and, in connection with them, the cost of installing the hydraulic plant, the cost of installing the steam plant, the cost of shafting, pulleys, ropes, &c., used in transmission, and it would be more complete to have the cost of the dynamos added, when, by a comparison of these facts with those known in other cases, the engineer is best able to judge of the value of the installation from a commercial standpoint.

Robert Cartwright, M.Am.Soc.C.E.: My experience in hydraulic work has been that wet brick softens the skin so the constant attrition with the brick very soon removes it, and sore fingers is the result. I always provide my men with rubber finger covers, and keep a supply on hand for use at all times. If I cannot get the rubber covers, I buy leather harvesting mittens for the purpose. I differ entirely with Mr. Green as to the brick being only "damp." I want them "soaked." When work is laid with soaked brick with hydraulic mortar, as our president has truly said, "the adhesion of the mortar to the brick is greater than the cohesion of particles of the brick among themselves." I do not expect, in building hydraulic masonry, to run the wall up as rapidly as with dry or damp brick, as the work would be apt to "bulge," but judgment in carrying the work on enables the engineer to shift his men on the work, giving the mortar time to harden before overloading it.

THE USE OF MOTOR COMMUTATORS.

If the public lighting of our streets could be satisfactorily accomplished by a number of alternating current arc lamps run in series off the omnibus bar of any alternate current station, nothing more could be desired in the way of simplicity and ease of manipulation.

Unfortunately, notwithstanding the enormous amount of time, trouble, and money devoted to solving this problem, every one has signally failed, and the continuous current remains unrivalled for the purpose of arc lighting.

The most complete proof of this is the number of alternating current stations, in which special continuous current dynamos and engines to drive them, have been put up for the sole purpose of running the arc lamps. This, of course, necessitates greater outlay and more trouble in working.

In the first place, there is the extra capital expenditure on arc light machines, engines, belts, and steam and exhaust pipes; then there is also the extra cost of building and foundations to receive this plant. But if these were the only disadvantages it would not be so serious; there is, however, the extra cost of attendance, which is greater in these small plants than in large ones. The repairs and maintenance are much heavier, and the efficiency is much lower than that of the large engines and dynamos in the station. The electrical energy thus produced for running the continuous current arc lamps, though in the most suitable form, is obtained at a great cost.

The great merit of the motor commutator is that it enables all the advantages of both these systems to be retained, whilst it completely does away with every disadvantage cited above.

Briefly, it enables the alternating current generated under the most favourable conditions by the large dynamos to be employed for the arc lighting. After passing through the constant current transformer, which gives it the property of being limited in quantity to the right amount and automatically varied in volts according to the number of lamps turned on, it is passed through the motor commutator, and is turned into a direct pulsating current.

The advantages of running arc lamps by means of the motor commutators do not even end here. A casual observer would think that there could be nothing better than the simple continuous current for arc lighting. This, however, is not so. The wavy direct current supplied by the motor commutators is greatly superior, as it keeps the lamp in a state of vibration, and this makes it most sensitive and a very perfect regulator. The effect of this in practice is that there is an unprecedented regularity in the burning of the lamps, and the practical value of the lighting is greatly enhanced. To this is coupled the fact that a most perfect crater is obtained, in all respects similar to actual continuous currents.

THE WATERHOUSE ELECTRICITY METER

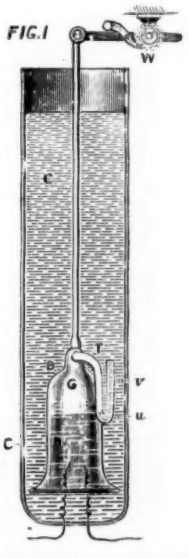
Recently we had an opportunity of watching this meter in operation at the Waterhouse Electricity Works, and have seen curves taken off the meters registering with various currents.

The apparatus is the best of its class yet brought to our notice, as it depends on a definite measuring principle, is positive in action, and free from the extreme delicacy common in other meters. It is compact and not likely to get out of order, and should not be expensive to manufacture. The curves made out by the inventor are wonderfully straight and show extreme accuracy throughout the whole range of the meter, but as we have no experience of the performance of the meter ourselves, nor any results of independent tests, we shall not enter into that part of the subject, for if the Board of Trade inspector passes a meter, that in itself may be taken as sufficient guarantee for its accuracy.

It is only used in continuous current work, and various methods of connecting the meter to the supply mains are the chief features in the invention electrically. Mechanically, the glass siphon bell is also of great interest, as it is very simple, accurate, and effective as the measuring organ of the meter.

The meter is of the class known as electrolytic meters; its mechanical part consists of a means of measuring and registering the volume of gas produced by a small fraction of the current used by the consumer. The means of measuring the gas consists of a novel glass collecting bell provided with an inverted siphon tube through which is discharged the gas when a certain volume has been collected, at the same time moving a registering mechanism, which indicates the number of times the collector has been filled. This mechanism is free from any complications or valves, and cannot be affected by wear or corrosion. Fig. 1 shows the

FIG. 1



electrolytic cell, C, and the collector, B, with the inverted siphon tube, T, which is partly filled with gas, G. After the gas has accumulated until it forces the fluid down to the bend in the tube, u, it will start up the tube at v and escape, leaving the bell full of fluid and ready to collect another charge of gas. W represents an indicator which is worked by the rise and fall of the collector, B; W is provided with pointers and dials indicating the number of times B has been filled with gas.

In the practical construction of this meter, certain difficulties which have heretofore appeared as inherent objections to electrolytic meters in general, had to be overcome.

In order to explain the electrical parts of this meter, reference is had to the accompanying drawings.

Fig. 2 shows E as the source of energy and L the lamps, R is a small resistance in the main line, N, and P is the positive wire to the lamps. If from P to N is 100 volts, we

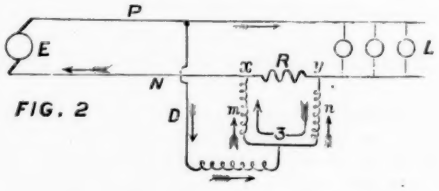


FIG. 2

place a derived circuit, D, having 1,200 ohms from N to 3, where it divides between m and n, each branch joining wire N, at the extremes of the resistance, R, or at x and y. Now if no current is passing to the lamps, L, none is returning through the resistance, R, and therefore there is no fall of potential between x and y; the result is that the derived circuit current starting from P to 3, and then dividing between m and n, in an inverse proportion to their resistance, will mostly pass to wire N on branch n, as its resistance is comparatively low, and a very small part on branch m, as its resistance is comparatively high, and the direction of these branch currents will be as indicated by the short arrows. Now if a current starts to the lamps, L, and returns through R on line N, there will be a fall of potential between the extremes of R, or between x and y, which will correspond to the amount of current passing from the lamps, so as this current passes through R, some of it will tend to pass around the shunt formed by n and m in the direction of the long bent arrow, and this current will oppose the derived circuit current from 3 up through n, and compel more of it to pass up through m, the current through m will increase with the

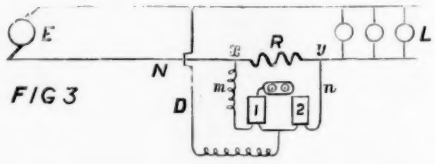


FIG 3

change of potential between x and y, due to the volume of current returning from the lamps. So in order to measure the change of current in m, we insert an electrolytic cell with a means, as shown, of measuring the current by measuring and registering the volume of gas evolved by such current; and to prevent any effect due to changes of resistance caused by heat or change in the specific density of the liquid, we place a like cell, without any measuring device, in branch n (see fig. 3), so that they may both be under the same conditions and mutually counteract for each other the effect of any disturbing changes.

As the difference of potential between x and y is limited to ·5 volt, and the counter E.M.F. offered by cells 1 and 2 is over 4 volts, it is evident that none of the current passing through R will pass around by way of the shunt formed by resistance m, cells 1 and 2, and conductor, n, but the difference of potential between x and y caused by the current in R, will cause a corresponding proportion of current to flow through cell 1, in which it is measured by means of the gas it produces, that would otherwise flow through the cell, 2. As we measure the current which passes through R, indirectly, by measuring the part of the shunt current which comes through D, and divides, so that a part will pass through the measuring cell, 1, which will correspond to the current in R; it is plain that a constant quantity of current must flow through the derived circuit, which in common use would not be constant owing to the changes of voltage between the main lines, P and N, and to remedy this defect a third cell is used in one form of these meters, as shown in fig. 4.

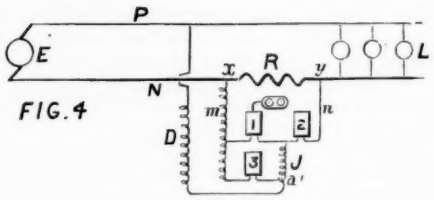


FIG. 4

This cell, 3, is placed as a shunt around cell 1 and the resistance, J, so in this way a complete meter is arranged, and if adjusted to 100 volts, the derived circuit current will divide between the cells, 1, 2, and 3, and the proportion going through the measuring cell, 1, will vary with the main current passing through R; if the voltage varying, causing more or less current to pass through the derived circuit, cell 3 will take more or less current, so as to keep the amount of current which divides between cells 1 and 2 constant; this is proven by a meter fixed according to diagram, which is the same as fig. 5, except that the derived circuit, D, is done

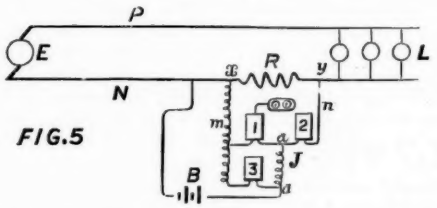


FIG.5

away with, and in its place a local circuit is formed extending from main wire, N, and then back to it, through the branches having the cells, 1, 2, and 3; to produce a local measuring current, batteries B are used. In this form the current will shift in 1, to correspond to the main current in R, and if more or less batteries are placed in B, the current in cells 2 and 3 will vary in proportion, but the current in 1 will remain the same at all points corresponding to the current in R.

Another way of constructing this meter is shown by fig. 6, in which the floats in cells 1 and 2 work the indicator, D, in opposite directions, so that when a very small current is passing through R the action of cell 2 will nearly counteract that of cell 1, but when the current increases in R, it will increase in cell 1 and diminish in cell 2, and the indicator, D, will show the difference due to the current in R.

This form of meter, as shown in fig. 6, has several very

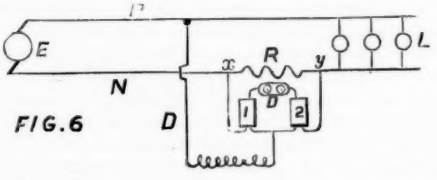


FIG.6

important advantages over any other form, which will probably cause it to be the one adopted. Owing to its differential action extreme sensitiveness is attained, which enables it to take a wide margin of measurements, as it will record the current used from a small fraction of one lamp to almost any desired number. As it is free from any complications of resistances or parts requiring careful measurement, it is easy at all times to calibrate, and can be worked or understood by anyone having a slight knowledge of electricity. Change in the voltage does not materially affect this meter, owing to the fact that as it works differentially, any change in the derived current will balance itself on both sides when no lamps are burning, and when lamps are put on,

any change of current in the derived circuit, if increased, will reduce the changing-over effect of the main circuit current on account of the increased difference of potential between the extremes of the paths through the meter, and, in case of a fall of voltage, opposite effects will compensate for the difference. The curves produced by this meter in actual practice prove it to be capable of the utmost accuracy of measurement.

A special device is used in this meter, but not shown, which stops the shunt circuit current when all the lamps are turned out, and starts it as soon as one lamp is turned on.

In refilling the cells used in this meter, nothing but pure water is added after the first filling, and this only once every three months.

As pure platinum electrodes and clean acidulated water are used, no corrosion or change occurs in the cells, even if they are worked for years without cleaning or renewing.

We show in fig. 7 a clear view of the measuring bell, with

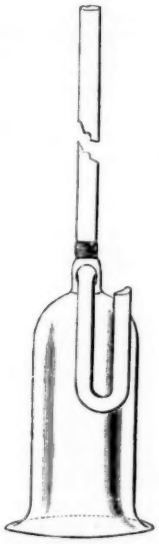


Fig. 7.

the little siphon on its side; the vertical rod of glass is merely a guide, and to it is attached the recording mechanism.

The gas collects in the bell, gradually floating it up, and as it fills with gas, the pressure increases within the bell, until it is sufficient to expel the water and acid solution round the lower bend of the siphon, and out by its vertical

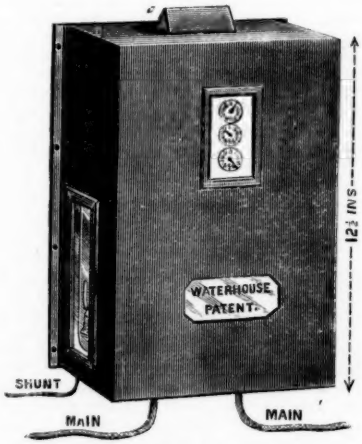


Fig. 8.

branch; the gas rushes out, and the bell falls by its own weight in the solution, and it is this falling weight of the bell which turns the index train of wheels.

As a whole it is very ingenious, and contains novelties of considerable originality, and we trust, when submitted to the test of actual practice, it will sustain the high opinion we have formed of it.

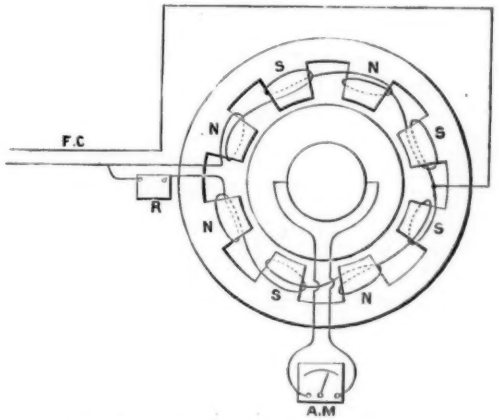
SIMPLE METHOD OF TESTING LARGE DYNAMOS.*

By G. M. WARNER.

A scheme I have often used for testing large dynamos but have never seen in print may be of interest. The name of the originator of the method has slipped my memory.

We often wish to know the effect of a run at full load on the temperature of a dynamo, and in the case of very large machines a long run is very expensive. By this method, any multipolar machine with series wound armature can be so tested, using only about 3 per cent. of its rated horse-power.

The accompanying illustration gives the connections, the fields being separately excited and so connected that half of the poles are reversed from their normal polarity. With the



F, C, field current; R, rheostat; A, M, ampèremeter.

machine at full load and normal current in the fields, we get no potential at the brushes, for the voltage generated in one-half of the armature is equal and opposite to that generated in the other half. If we weaken the current in one-half of the poles by a very little, the opposed E.M.Fs. are no longer equal and we get a potential difference of a few volts.

Hence, driving our machine at full speed and exciting the fields with their normal current, being careful that the adjustments are right to give zero potential, we short circuit the machine by an ampèremeter, then very slowly weaken half the fields until full load current flows in the armature. So we have full load currents in the armature and fields, the amount of weakening being negligible, nearly the same iron losses, and only have to supply energy for hysteresis and resistance losses.

With alternators, the weakening of the fields is somewhat more, as we have to supply the self-induction voltage of usually 800 volts, still the results obtained are accurate for most commercial purposes.

* New York *Electrical World*.

WOODHOUSE & RAWSON UNITED, LIMITED.

An announcement which appeared in last Friday's *London Gazette* comes not altogether as a surprise to us, and it could hardly have been unexpected by those of our readers who have followed, from time to time, the complicated proceedings of Woodhouse & Rawson United, Limited. The flotation of companies by prospectuses, since alleged by shareholders and others to contain misrepresentations, the payment of large dividends in

cash when they only appeared on paper, the liability of the directors whose names have been put forward as supporters of the statements in the prospectuses; these and the various other allegations in connection with this disastrous business, have now been investigated as far as his present powers allow, by Mr. C. J. Stewart, the official liquidator, with the result that a public examination of fourteen gentlemen, directors and others connected with the concern, is to be held at Bankruptcy Buildings on Monday, Tuesday, and Wednesday next, June 18th, 19th, and 20th. From the moment Mr. Stewart was put in charge, we have recognised that of all men he was the most suited to investigate and bring to a just and clear issue the various matters. He is a clear-headed searching investigator, fully equal to the task of probing the many points in the complicated finances of Woodhouse & Rawson United, Limited, and its offspring —the many subsidiary companies—which are most of them in almost as unhealthy and precarious condition as the parent company. The examination will be watched by us, and doubtless by the whole electrical fraternity with the greatest interest. The following are down for examination:—Lord Aberdare, Sir Rawson W. Rawson, Sir John Stokes, Samuel Pope, Q.C., F. L. Rawson, W. T. Stutchbury, Albert Hoster, T. H. Lambert, C. L. Baker, Philip Rawson, A. L. Foley, J. H. Owen, Malcolm Dundas, — Mumford, F. W. Pixley.

LEGAL.

Edison-Bell Phonograph Corporation *v.* Smith and Young.

(*Continued from page* 675)

On Friday last week, in continuation of the two preceding days' hearing, the Master of the Rolls, and Lords Justices Kay and Smith resumed their consideration of and delivered judgment in the appeal of Messrs. Smith & Young from a judgment of Mr. Justice Wright in February last, holding them, at the suit of the Edison-Bell Phonograph Corporation, Limited, to have infringed Mr. Edison's patent of 1889 for an improvement in the phonograph, and directed the forfeiture of the infringing instruments.

The Master of the Rolls, on their lordships taking their seats, intimated that they were ready, without hearing counsel for the respondent plaintiffs, to give judgment on the appeal, leaving for after consideration the minor question of the forfeiture of the infringing instruments. On this,

Sir Richard Webster, Q.C., the respondent corporation's leading counsel, said this point was not taken at the trial until the end. Mr. Bousfield, on Mr. Justice Wright giving formal judgment, leaving the details for a future day, undertook, on the part of his clients, not to part with the instruments in this country pending the delivery of the detailed judgment, the circumstances of the case being special. The patent related not to the whole, but only to certain parts of the machine, and it was possible that, removing these parts, the frame and body of the phonograph might still be sold. He now suggested that justice would be done by plaintiffs taking off the infringing parts, and the machines being marked.

The Master of the Rolls said he thought this might lead to some difficulty, and an arrangement might well be drawn up by junior counsel in the case, as the only part of the judgment of Mr. Justice Wright which this Court proposed to vary. Proceeding to deliver his judgment, extending over some half an hour in length, the machine, he observed, defendants admitted they had brought to England and sold, and so the infringement was proved. But defendants, finding this, raised the point that the patent was invalid; it was a bad patent, and could not be sued upon—a common resort in cases like this. An attempt had been made to persuade the Court that some sentence in the specification or patent was so bad as to make the patent bad, and in these circumstances the Court, not favouring such a defence, would look carefully to see whether any of the objections could be sustained, and take care that they were strictly proved. Now, the first question that arose was, what was the proper rule of construction of the patent? He quoted the late Lord Hatherley and Lord Justice Lindley to the effect that to act fairly you must look at the whole of the patent or specification, and construe it upon its general character, and not upon isolated sentences. Adopting this as the correct view, they had in the present case in the specification an elaborate description of what had been invented—of certain improvements described with much particularity, and elaborate references to plans, distinguishing letters and numbers, making each of the descriptions of claim perfectly plain. Something had been attempted to be made of the doctrine usually known as what a workman of ordinary skill would do with such a document before him. That doctrine, however, was not applicable to the present case, but only where the description of what was designed to be done was so ambiguous to a man without knowledge of the subject, that a workman of ordinary skill might be asked its meaning, and how he read it. But, as he had said, it had not been suggested that any of these claims were so ambiguous as to require them to be interpreted. They were brought, therefore, to the inventor's claim of a desire to simplify the construction and facilitate the operations of the phonograph, by increasing a number of the parts of the machine, and avoiding the necessity of its adjustment in working; and next came the statement that having particularly described and defined the nature of the invention, and the manner in which the same was to be performed, he claimed as new an attachment both for recording and reproducing points with the same diaphragm, instead of by two diaphragms, as before. Than this, it seemed to him (the Master of the Rolls), nothing could be plainer, and if so, the claim could not be held, as the Court was asked to do, as too large, and it did not come within the doctrine that if any one claim was too large it vitiated the whole patent. The main objection of the appellants, therefore, failed; and the same considerations applied to all the objections raised to the other claims. Passing these in review, his Lordship said it seemed to him that in each and every of these cases the inventor described that which he claimed, no more and no less. For himself, he adopted precisely the view Mr. Justice Wright took of the matter, in language which he read from his judgment, to the effect that plaintiff claimed for a particular arrangement which had never before been made practicable, and had now been found practicable in the way disclosed by the specification, and such claim ought properly to be construed as a claim to a monopoly. He agreed with this decision as applying to each and every one of the plaintiffs' claims. The suggestion that the spring lock was wanting in subject-matter, he must be excused for saying he heard with amused contempt, because it came to this, that although nobody had ever thought of the proposed improvement before, and although it was useful as well as new, yet when you came to consider it, it was so palpable that, to use a less judicial than expressive phrase, "any fool could do it." Considering that there was no evidence that anybody had ever before dealt with such a matter, that it was an improvement upon an old thing, and different to what was before known, and that it was useful, he could not disagree with Mr. Justice Wright's conclusions and decision in the matter, and he thought the appeal substantially failed in every respect, though the order so affirming it would be varied in the matter of the forfeiture of the infringing machines. The appellants, subject to this amendment, could not be relieved from the judgment against which they appealed, and would have to pay the costs.

Lord Justice Kay said he agreed entirely with the judgment just given by the Master of the Rolls, and also with the very able judgment of Mr. Justice Wright, and he desired to add only a few observations. This was a case in which the infringement had not been, and could not be, denied, because the defendants had purchased in America, and sold in this country, machines made exactly in accordance with this patent, and adopting all its improvements. The patent for which in England, they were told, had been sold to the plaintiffs in this case. The infringement, therefore, was plain, and was not attempted to be denied. It should be remembered that this was not a patent for the whole machine. The phonograph, they were told, could not be patented in this country; but the patent was for certain improvements by the original inventor, whose description the learned judge read, and went on to say that the general doctrine of the construction of a patent might be summarised in a sentence taken from Frost's book on Patents, that the Court would not be too astute to find flaws of a small matter in the specification with a view to overthrow it. His Lordship passed in review the various claims of the patent, and saying he was not satisfied the claim was too wide, he compared and detailed the claims whose consideration led him to decline to read it in that sense. Nor was he at all satisfied that the claims had been in the least degree vitiated by what were called specific arrangements in the former patents, or that some of the claims lacked invention, as had been submitted, notably the guide rest, the knife, and the nut sections. The result was his general agreement with the very able judgment given in the Court below, and concurrence in its confirmation.

Lord Justice Smith said he, too, concurred in what he regarded as a peculiarly clear and lucid judgment, the attack made upon which had signally failed. He cited the late Chief Baron Pollock and Lord Justice James as to what was the province of a claim, and what a patentee could claim; and, turning to the objections raised to the respective claims, he commented on each in succession, and said he so regarded them as complying with all the requirements of the law for holding a patent good, that he had no hesitation in agreeing with what Mr. Justice Wright found in effect. He concurred, therefore, in holding that the appeal had failed, except in regard to the trifling variation which it was understood junior counsel would draw up.

The appeal was consequently dismissed with costs, subject to a modification as to the forfeiture of machines, which it was admitted did not wholly infringe the plaintiffs' patent.

Sellmann *v.* Brasyer and Another.

Litigation has arisen from the recent Harness prosecution. The first action was taken by Robert W. Sellman, better known in his connection with the Medical Battery Company as Dudley Towers. It will be remembered that his was the fourth and last arrest effected in the Marlborough Street prosecution, and he was charged with being in league with the others who were arrested. After being remanded a number of times, the charge against him was withdrawn, and he was released from the dock. Shortly after this he made a claim against Colonel Brasyer and Mr. F. T. Burbage, two of the prosecutors, for damages for malicious prosecution, and this action came before Mr. Justice Mathew and a special jury on Thursday last week, and lasted until Saturday, the 9th inst. The defendants pleaded probable and reasonable cause. Mr. Jelf, Q.C., and Mr. Avory appeared for the plaintiff, and defendants were represented by Mr. De Witt, Q.C., and Mr. T. Terrell.

Mr. Jelf, having opened the case, the Plaintiff was called, and in answer to Mr. Avory, said that at the Oxford Street establishment he had a room in the saloon, which was fitted up with batteries and

other means of applying electro-massage. He had nothing whatever to do with the financial part of the business, or with the fees paid by patients. He denied having asked Mr. Burbage to give him a present. Mr. Burbage sent him a box of cigars, and 12 months afterwards he sent in a bill for them. Since leaving the Medical Battery Company he had had nothing to do with that business. At the time of his arrest he was making an income of from £10 to £15 per week.

In cross-examination, WITNESS denied that he had said Mr. Harness was a rogue. He might have formed an opinion as to Mr. Harness's character, but he should not say what that opinion was. He strongly denied that Mr. Harness was paying the expenses of this action. To defray the cost he had given a bill of sale on his furniture.

The plaintiff's wife and Mr. W. Pitman, a solicitor's clerk, having given evidence,

Mr. RICHARD FURBER, solicitor, said that at the police-court Mr. Terrell, who appeared for the prosecution, said he represented Colonel Brasyer, Mr. Burbage, Mrs. Wilcocks, and Mr. Manners. There was no ground for the suggestion that Mr. Harness had instigated the present proceedings. Witness, in cross-examination, said that Colonel Brasyer had brought an action against Mr. Harness, and Mr. Harness had put in a counterclaim for malicious prosecution.

Mr. WITT then opened on behalf of Colonel Brasyer. He said that his client was an old gentleman, 84 years of age. He joined the army as a private soldier, and by his deeds of valour in India he attained his present position in the army. Colonel Brasyer denied that he ever preferred any charge against the plaintiff, though he admitted that he prosecuted Mr. Harness and Dr. McCully.

Mr. TERRELL, on behalf of Mr. Burbage, said that his client admitted that he caused the prosecution of the plaintiff, but he contended that he had reasonable and probable cause.

Mr. COLLIER, a member of the firm of solicitors who were acting for Col. Brasyer, having given evidence, the defendant, Mr. Frederick Theobald Burbage was called.

In cross-examination WITNESS said he still believed the plaintiff to have been guilty of fraud.

Learned counsel then addressed the jury on behalf of their respective clients.

His LORDSHIP having summed up, the Jury retired to consider their verdict. After having been locked up for some time they were unable to agree, and in the result they were discharged without giving a verdict.

THE MEDICAL BATTERY COMPANY.

NOTIFICATION is given by Mr. C. J. Stewart, the official receiver and liquidator, that Mr. Justice Vaughan Williams has directed separate meetings of (1) the holders of debentures and the secured creditors of the company; (2) the unsecured creditors; and (3) the contributories to be summoned for considering and, if thought fit, approving a scheme of arrangement to be made between the debenture-holders, the secured and unsecured creditors, and the contributories. The meetings will be held on the 15th inst. at the Inns of Court Hotel, Holborn.

B. NEWGASS & CO. *v.* THE GULCHER ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

IN this case, on Friday, the 8th inst., Mr. Justice North, in the Chancery Division of the High Court of Justice, appointed a receiver of the company at the instance of the plaintiffs, who are debenture-holders. It was stated that resolutions had been passed for winding up voluntarily. The company appeared, and offered no objection to the order.

CORRESPONDENCE.

Muirhead v. Commercial Cable Company.

Referring to the editorial article in your paper of the 4th instant in reference to the Muirhead patents, I am sure it will interest your readers to know that our experience shows that you are quite right in your suggestion that the rheostat at the apex of the bridge has not contributed better results than had ever been obtained before, and that it is the condenser and not the rheostat that improves the working. When our duplex was first established, we were cautioned never to touch the rheostat unless it was absolutely necessary, on the ground that a balance obtained when the pointer was off the centre was one that would not remain constant, and for months at a time the rheostat in my company's apparatus has remained unchanged whilst we were balancing. I may tell you that we have, in fact, entirely dispensed with the rheostat on one of our long cables, and on our Canso-New York cable (which is electrically a long cable), we have simply joined the two blocks of condensers on the key side of the bridge by a wire of practically no resistance. There is absolutely no diminution of speed nor change in the character of the signals, nor is the balance in the slightest degree more difficult either to obtain or maintain.

As you rightly say, an ounce of experience is worth a pound of theory.

Geo. G. Ward,
Vice-President and General Manager,
Commercial Cable Company.

New York, *May 26th*, 1894.

Wire Computing.

There appears to be advantages in speaking of wire by its sectional area in thousands of an inch, rather than adopting any of the various gauges. Looking through back numbers of the REVIEW, I notice that the Brush Company do this, and by so doing are able to preserve a constant relation between size and resistance. Taking their rule (yards per ohm = Sa × ψo) and shaping it into a table of ohm-yards and sectional area, two important sums are quickly worked out.

Ohm-yards.	Ohm-yards and sectional area.			
	10,000	1,000	100	10
	Sec. area.	Sec. area.	Sec. area.	Sec. area.
1	250	25	2·5	·25
2	500	50	5·0	·50
3	750	75	7·5	·75
4	1,000	100	10·0	1·
5	...	125	12·5	1·25
6	...	150	15·0	1·50
7	...	175	17·5	1·75
8	...	200	20·0	2·
9	...	225	22·5	2·25

Example:—Required the sectional area of a conductor 6,304 yards long, to offer a resistance of 8 ohms.

8) 6.304
788

Converting 788 ohm-yards into sectional area by above table, we get

Sectional area for 700 = 17·5
" " 80 = 2·0
" " 8 = 0·2

Total sectional area required = 19·7

Example:—Required the sectional area of a conductor 1,855 yards long, conveying 40 ampères, with 5 volts to be lost,

1,855
40
5) 74,200
14,840

Sectional area for 10,000 = 250
" " 4,000 = 100
" " 800 = 20
" " 40 = 1

Total sectional area required = 371

The above mode of tabulating constants might be extended to other electrical calculations.

J. F. D.

Theryc-Oblasser Battery.

I have the pleasure to send you herewith a cutting from the *Journal de Liège*, with the report of the trial of tramway traction with the Theryc-Oblasser secondary battery, under the auspices of the well known engineers and constructors of Liège, Belgium, Messrs. Carl Braconier and Dierman. To them and to their engineers the full credit is due for the decided success of the present experiment.

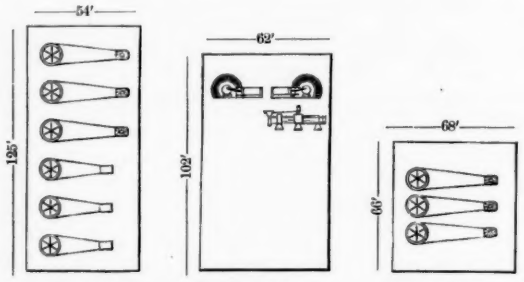
I hope that this result will encourage those who hold this valuable invention here to bring it to a like success. Six hundred kilogs. per battery must be read 600 kilogs. of plates; this will make 1,000 kilogs. per battery, or *one ton*. On May 24th the battery propelled the car 75 kilometres, or about 46½ English miles at 12 to 15 kilometres, or from 7½ to 9⅓ miles per hour, which was its normal speed.

I take this opportunity to state that I had much to do with this battery when first introduced in this country, and know it well, but have now no material interest in the business whatever.

A. Schanschieff.

NOTES.

Portsmouth.—What we consider to be the most important illustration in our last week's issue, the Comparison of Stations, was, in the course of printing, somewhat marred by sundry figures of measurement being knocked off. We reproduce the blocks herewith, and the space saved by the Portsmouth system may be seen at a glance. Of course the diagrams of the Leeds and Blackpool stations do not take into account the extensions which, we believe, are already being made.



Capacity of station, 320 units. BLACKPOOL.
Capacity of station, 570 units. PORTSMOUTH.
Capacity of station, 250 units. LEEDS.

COMPARISON OF STATIONS.

Another point with reference to Portsmouth, which we would like to correct; we said that the whole of the cables inside the station had been made by the British Insulated Wire Company, but it appears that though the B.I.W. did supply a good deal of the inside cables, Messrs. Glovers supplied some as well. We ought likewise to have mentioned that Mr. Portelli was the resident engineer for Messrs. Glovers, and during many months worked energetically in directing the laying of the mains.

British Association, 1894.—An Oxford correspondent of one of the daily papers says that the preparations for the annual meeting of the British Association in Oxford are progressing in a satisfactory manner, and the gathering promises to be very successful. Already upwards of 1,000 persons have intimated their intention of being present, and nearly 100 of the most distinguished scientists on the Continent have accepted invitations. The President of the Association (the Marquis of Salisbury) will be the guest of the Warden of All Souls, and will deliver the opening address on August 8th in the Sheldonian Theatre. Several popular evening lectures will be delivered. The guarantee fund has now reached £3,000. Excursions to various places of interest have been arranged, including Windsor Castle, Dropmore and Taplow Court, Silchester, Reading, Blenheim, Swindon Railway Works, Faringdon, Abingdon, Dorchester and Wallingford, Warwick Castle, Stratford-on-Avon, Wroxton Abbey, Broughton Castle, Edge Hill, and Compton Wydmattes, Fairford, &c. The Lord-Lieutenant of Berkshire (Lord Wantage), of Lockinge, Sir William Anson, and other gentlemen, will give garden parties during the meeting.

Blowing Hot and Cold with the same Breath.—In the case of Sellman *v.* Brasyer and another, when the jury disagreed on Saturday, Mr. Justice Mathew pointedly remarked that if he were on a jury, and found that the majority were opposed to the view he took, he should give in. The only way to arrive at a decision was by making mutual concessions. Only between two and three weeks ago Mr. Justice Mathew, in the Queen's Bench Division, when judgment was delivered in the case of the Queen *v.* Dennis, was the very identical judge who begged to differ with all his colleagues, ten eminent judges being of opinion that the conviction should be quashed, and Mr. Justice Mathew alone holding that the conviction was right. It is evident that Mr. Justice Mathew in his capacity as a judge holds quite opposite views to Mr. Justice Mathew as a juryman.

The Portsmouth Banquet.—The Mayor of Portsmouth writes to us as follows:—"As the banquet at the Town Hall on Wednesday last was given and paid for by myself, I will thank you to correct your paragraph that it was given by the Corporation, as stated in your paper, page 674.—Yours truly, A. LEON EMANUEL, Mayor."

Local Government Board Enquiries.—There are some anomalous, almost stupid, proceedings necessary before the electric lighting of a town can be proceeded with. A municipality secures a provisional order, but before building operations can be commenced it is necessary to receive the sanction of the Local Government Board to raise a loan. In the ordinary course of events an enquiry is held, and when the department has sufficiently sat on the matter, a tardy sanction will be given. What we complain of is the extraordinary delay that arises in granting these permissions. Take the case of Portsmouth. An enquiry was held by a Local Government Inspector, and little opposition was shown to the scheme of lighting, but it is a notorious fact that some five months elapsed before the sanction to raise a loan was granted. Finally, it was given in consequence of a distinct threat to bring the matter before Parliament. Such cases as this are bad both for the department and the public, and we appeal in all moderation to the head of the Local Government Board to see that public business of the class we have indicated is carried out more expeditiously.

Great Northern Telegraph Company.—As we stated last week, festivities were held in Copenhagen on 1st inst. to commemorate the twenty-fifth anniversary of the formation of this company. In honour of Hans Christian Oersted as a pioneer in telegraphy, his statue was decorated with garlands of laurel. Commodore E. Suenson, the managing director at Copenhagen, was presented by the staff with a splendid album containing water-colour views of all the company's stations, repairing steamers, &c. A "complimentary umbrella," lavishly executed, was presented to him from the "Far East" staff. Mr. C. F. Tietgen, the chairman, was presented by the directors with a marble bust of himself to be placed in the company's offices; the board presented Commodore Suenson with a valuable silver table service. Further gifts and addresses were made by the staff to the chairman. At noon Commodore Suenson and his wife entertained a large company at dinner, over 200 guests being present. The usual toasts were drunk and speeches made, and the buildings afterwards illuminated. Hundreds of complimentary telegrams were received during the dinner.

The Electric Tramways at Siam.—The U.S. Vice-Consul-General at Siam, Bangkok, in a recent report, referred somewhat lengthily to the electric tramway enterprise carried out there recently by Americans. He says:—

An extensive improvement has just been completed in this city, in which Americans and American inventions have played the leading parts. I refer to the equipment with electricity of the only tramway line here, a tramway which has heretofore been run by horse-power. In the summer of 1891 the manager of this company made a tour of Europe and the United States, investigating the subject of motive power for street railways. After a thorough investigation of the methods used on both sides of the Atlantic, he entered into a contract with the Short Electric Company, of Cleveland, Ohio, to put in a plant here and equip three miles of road, the cost to be something like $50,000. In November, 1892, Mr. W. J. Davison, an electrician for the Short Company, arrived in Bangkok, and at once commenced work to carry out the contract, and has just completed his undertaking to the entire satisfaction of the company here—so much so, that they are contemplating an extension of the line. Since the first car was started, some three months ago, the receipts have increased wonderfully. Now, with the entire line completed, enabling the company to run four cars, the increase in receipts has been 30 per cent. This is the first electric road in the far East, and the satisfactory manner in which this contract has been carried out, will not only redound to the credit of the Short Company, but to the electrician, Mr. Davison, whose efforts in their behalf have been crowned with such signal success. More roads of this character are sure to follow in the East. Very much interest could be aroused here in such things, in my judgment, if the electrical companies at home would send representatives out to the Orient to put their claims before the proper people.

The tips here given are intended for America and the Americans, but Englishmen and Europeans generally should turn them to good account. A good field will doubtless open up over there shortly.

Pacific Cable.—The Australian and Canadian mail steamer *Arawa* has arrived at Victoria, British Columbia, from Australia, Fiji, Samoa, and Hawaii, with the delegates from the Australasian Colonies for the Inter-Colonial Conference at Ottawa on board. The White Star steamer *Teutonic*, which sailed from Liverpool on Wednesday, had on board Hon. Sir Henry de Villiers, Hon. G. Hofmeyr, and Sir Charles Mills, delegates from South Africa. The Earl of Jersey, accompanied by two or three officials of the Colonial Office, proceeds in the same steamer to represent the Imperial Government at the Ottawa Conference upon Colonial Inter-Communication and Colonial Federation, which opens on June 21st.

The Minimum E.M.F. Required in Electrolysis.—An important contribution to our knowledge of the electrolysis of alkali salts has been made by C. Nourrison, who recently described his investigations on the subject before the Paris Academy of Science. He demonstrated that the minimum E.M.F. required for the electrolysis of such salts, in aqueous solution, is constant for salts of the same acid. His results, given in volts, are as follows :—

	Chloride.	Bromide.	Iodide.	Sulphate.	Nitrate.	Chlorate.
Potassium ...	1·97	1·74	1·15	2·40	2·32	2·45
Sodium	2·10	1·71	1·19	2·40	2·36	2·42
Lithium ...	2·01	...	...	2·43	2·45	...
Calcium ...	1·95	1·71	1·16	...	2·28	...
Barium	1·94	1·72	1·17	...	2·37	2·48
Ammonium ...	1·83	1·46	...	2·29	...	...
Calculated values	2·02	1·75	1·16	2·15	2·07	2·07

The solutions thus compared contained the same number of equivalents per unit volume.

Coast Communication.—In the House of Commons last week, in answer to Mr. FitzGerald, Mr. Bryce said :—"In the last financial year £10,000 was placed at the disposal of the Board of Trade for the purpose of effecting electrical communication with light vessels, &c. That money was expended in connecting the Kentish Knock and the Goodwin (N. Sand Head) light vessels and the Gunfleet Pile lighthouse with the shore. In the present financial year £11,000 has been similarly placed at the disposal of the Board of Trade, and it is intended to expend this amount in connecting the Haisborough and the Shipwash light vessels with the shore, and in laying a cable to the Tuskar Rock lighthouse. I am afraid that the other works recommended by the Royal Commission must wait until the Treasury can place more money at my disposal." The provision of electrical coast communication is a matter of far greater importance than some questions receiving more prominence at the hands of the present Government, and it is earnestly to be hoped that the funds of the Royal Commission will be replenished very shortly by the Treasury, to enable them to proceed with a work of national necessity.

Lithium.—The manufacture of metallic lithium by means of electrolysis appears at first sight very simple, but when it is required in any great quantity the operation is critical, and needs the greatest care in the adjustment of the current strength. The process has lately been investigated by M. Guntz (*Compt. Rend.*, 117, 732); he shows there the necessity for using an electrolyte of low fusion point. Pure lithium chloride melts at 600°, a mixture of equal parts of lithium and calcium-chloride melts at 450°, and a mixture of equal molecules at 380°. For obtaining metallic lithium, the author recommends, to begin with, a mixture of equal parts; this loses some of its lithium chloride during the operation, but finally approaches very near to the mixture of equal molecules, having the lower fusion point. From 200 to 300 grammes of the mixture are heated to the melting point in a porcelain crucible. A carbon rod of 8 mm. diameter is used as a positive electrode, and a Pt wire, carried in a glass tube, is used at the negative pole. The current should be about 10 ampéres. The decomposition is said to take place quickly, and the deposited lithium is free from iron and calcium. If the attempt is made to work with the lithium chloride alone the method fails, because at the high temperature required (600°) the Li deposited at the negative pole combines with the lithium chloride to form a sub-chloride, which is a bad conductor, and weakens the current.

Fly-wheel Alternators.—We hear that two or three prominent dynamo builders are contemplating building the fly-wheel type of alternator.

Southampton Town Council and Electricity.—The Town Council have approached the Southampton Electric Light Company on the subject of acquiring the electric light station.

The Use of Oil Fuel at Hull.—Mr. Gibbings, the electrical engineer to the Hull Corporation, has recommended the Lighting Committee to adopt oil fuel for the station. Mr. Gibbings has been authorised to make further inquiries.

The Resident Engineer for Sunderland.—Fifty-nine electrical engineers applied for this berth. The matter lies between Messrs. Snell and Brown, and the Council will decide shortly.

Retort Carbons.—In a report to the German Gas Society, Mr. Hempel remarked upon the high price of the large retort carbons which are now used as electrodes in electrolytical processes, and also in the manufacture of chlorine and sodium from common salt. Mr. Hempel thinks it might be possible to manufacture the plates in the retorts themselves; it would suffice for this purpose if smooth flat surfaces were provided at the parts where the carbon is deposited. He also suggests that the leading wires or binding screws could possibly be included in the plates as the process is in formation.

Association of Municipal Engineers.—At the annual meeting to be held in London, next Friday, papers will be read on the "Bradford Corporation Electricity Supply," by Mr. Shoolbred; and on "Electricity Street Trams," by Mr. R. Hammond.

The City Inspectorship.—For many are called, but few are chosen. The dovecotes of consulting electrical engineers and others in want of a billet have been considerably fluttered by the vacancy in the city for an electric light inspector. A personal canvas has been allowed, and the Commissioners of Sewers have during the past few days realised the importance of their position. We have reason to think that the cab strike has somewhat militated against the chances of some of the candidates, the chartering of cabs for a whole day being rendered extremely difficult.

An Improvement in Magnets.—It is odd that of recent years so little attention has been devoted to the better construction of powerful electro-magnets suitable for using in physical demonstrations and experiments. We still, for the most part, pin our faith to the old Rhumkorff magnet, which, though useful, no doubt should long ago have been relegated to the museums of antiquities, for it was designed before any lucid ideas whatever had been conceived concerning the magnetic circuit. Prof. H. Du Bois, of Berlin, has recognised the need there is for a handy magnet capable of producing intense magnetic fields, and has consequently designed a ring-shaped electro-magnet which is stated to be most useful in producing these effects in the laboratory or the lecture room. The magnet weighs about 500—600 lbs., and between conical pole pieces is capable of giving a magnetic field of 40,000 C.G.S. units over a space the diameter of which does not exceed 3—5 mm.

Electrolytic Iron.—It is very generally believed that iron and other metals which can be obtained by electrolysis are absolutely free from those impurities which seem to be the inevitable associates of these metals when prepared by the more common commercial processes. Absolute purity, however, is seldom attained, even in the manufacture of the highest grades of chemicals, for it is a matter of extreme difficulty to eliminate the last traces of foreign bodies. Electrolytic iron is superior to ordinary iron only in degree. This has recently been demonstrated by J. N. Lockyer, who has examined the spectrum obtained by using such iron as the poles of an electric arc lamp. The spectrum was photographed, and then carefully studied, with the result that evidences of the presence of calcium and manganese, as well as of minute traces of other metals, were discovered. After this, we must hesitate to affirm that a specimen of absolutely pure iron exists anywhere.

Electric Organ Blowing.—This subject is just now exercising the minds of the readers of the *Musical News*.

Ship Wiring.—The articles published in the *Pall Mall Gazette* and the Electrical Review appear to be bearing fruit. Our contemporary, a few days ago, stated that it hears from different sources that the committee of Lloyd's Registry are contemplating substituting definite rules on the subject in the place of their former suggestions, and that they are now engaged drafting such rules.

Electric Lighting of St. Luke's.—On most matters the Vestry have come to an agreement with the County of London and Brush Provincial Company on the subject of lighting the district. The points reserved are that the Vestry may, at any time, without opposition from the company, supply electricity themselves, and the proposed transformer chamber at Windsor Terrace is objected to.

Torquay Destructors and Electric Lighting.—The Sub-Committee's report to the Town Council on the question of the disposal of house refuse has been adopted. They recommended that the destructor consist of six cells, that provision be made for an installation of electric light, and for its extension if found satisfactory, that the chimney shaft be carried to a height of 200 feet, so as to reduce the possibility of complaint; that the chimney be made ornamental, and that plans and estimates be obtained.

A Laboratory Electric Furnace.—At a meeting of the Edinburgh Section of the Society of Chemical Industry, a short time ago, Dr. J. B. Readman exhibited a small model furnace which he had designed, and which he thought likely to be of much use to chemists who have the electric current at hand. It was evident, from Dr. Readman's account of the experiments which he had made with this furnace, that it possessed grave defects. For example, he had observed a tendency in the outer casing, which was of brass (!) to become over-heated; and this, he naïvely observed, might be due to higher currents than the carbon electrodes were suited to, or to his want of skill in handling the apparatus. From the discussion which ensued this description, it was evident that a great want is experienced by those who possess laboratories, especially by those whose work require the employment of very high temperatures. It is in such a case that the intelligent electrician can supply the want, and we refer this matter to those of our readers who are wishful for an opportunity of making themselves useful to a large body of industrious scientists, and with profit unto themselves.

Honours to French Electricians.—The following leaderette taken from the *Electrical World* expresses fully our own feelings on this subject, more especially the remarks regarding M. Hospitalier:—"The current number of the *Bulletin* de la Société Internationale des Electriciens announces that the President of the French Republic has conferred merited rewards upon a number of French electricians for their services in connection with the Chicago World's Fair. MM. Barbier, Carpentier, Lippmann, and Violle, have been promoted to the grade of officer in the Legion of Honour, and MM. De la Touanne, Milde, Picou, and Richard, awarded its decoration of Chevalier. Most of these names, particularly Lippmann, Violle, Picou, Richard, and Carpentier, are doubtless familiar to our readers, but the absence will probably be noted of those of two Frenchmen eminent in electrical science, who honoured the Chicago Electrical Congress with their presence, and whose writings are almost as well known in America as in France—Mascart and Hospitalier. Of these, Mascart has already reached the highest place on this distinguished roll, his splendid abilities having long since exhausted the official honours which France delights to lavish on her great savants. Without presuming to criticise the omission of the name of Hospitalier, perhaps the best known in America of all the eminent Continental electricians through the wide circulation secured for his works by their distinctively practical character, yet the gratitude which American electricians feel for his generous services in behalf of the henry, both in France and at Chicago, will give rise to a regret that he has not received a recognition which would also have been considered a compliment to the cause in which he laboured."

Electric Light at Cardiff.—It has been proposed to light the Market and Town Hall by electricity, and the borough engineer has been instructed to draw up a report.

New Cable.—The ss. *Faraday*, with the Atlantic cable for the Commercial Cable Company, left the works of Messrs. Siemens Bros. & Co. on Tuesday.

Municipal Gas and Electricity Undertakings.—The Burton Corporation Electricity Works are perhaps the first works in the country which have been placed side by side with the gas making plant. The gas works are, of course, owned by the Corporation, and the gas manager has had added to his duties those of electrical engineer.

The Fareham Company in Difficulties.—We regret to hear that this pioneer company is in difficulties, and it is likely that the undertaking may be relinquished. The Local Board, following the example set by the Brighton Corporation under similar circumstances, seem more disposed to crush than to help the company in its hour of need.

The City Electric Light Company.—To-night a demonstration of the use of electricity for cooking and heating, and afterwards a dinner cooked by electricity, will be given by the City Company at the Cannon Street Hotel. It is expected that the Lord Mayor and the City Sheriffs will be present.

Stores Lighting.—We understand that the Francis Street and Coburg Road depôts of the Army and Navy Stores, Victoria Street, Westminster, are to be lighted electrically with some 1,500 lamps. We should be glad if any of the contracting firms who are estimating for this work will, for special reasons which we cannot now explain, notify us of the fact.

The Highest Tender Accepted.—Bearing in mind the extraordinary disparity which so often exists in electrical tenders, it is refreshing to hear that in one case the highest tenderer was called in to account for the difference between his tender (£7,000) and the lowest (£4,000). So satisfactorily was the matter explained—it being shown that £4,000 did not cover the cost of raw material—that the highest tender was accepted without hesitation. To expect many to follow this example is hoping for too much.

The Fire at Dr. Talmage's Tabernacle.—One of the American electrical journals makes some very strong remarks regarding the recent, and third, demolition of Dr. Talmage's edifices by fire. The long and short of those comments is that the cause of the fire was not electricity at all, but incendiarism, and while Dr. Talmage himself is absolutely free from the slightest suspicion, our contemporary has not the greatest faith in some of his church supporters, but considers the cause of the fire might be traced home to certain of them. Recently the church was not in a very brilliant condition financially, and the popular American preacher announced that he must resign his pastorate, though later on he changed his mind; a few weeks after that the fire occurred, and now we learn from despatches in the newspapers that the Doctor has gone on a tour round the world. We do not say decidedly that these facts have any particular bearing upon the matter, but they may have. One of the officials of the church ascribes the conflagration to the merciful intervention of Providence in delivering the church from its financial embarrassments. If such is the case why blame electricity for the mysterious workings of the Almighty? Would the fire insurance companies consider this a reasonable cause? We think not. We hardly imagine Providence would extract from the funds of a useful insurance company a large sum of money to keep in existence a church which is asserted to be nothing more than a scandle in its neighbourhood. *Electricity* recommends the insurance companies to do their duty in the matter, and thoroughly investigate the whole affair, for certainly as things now stand they look most unsatisfactory. There appears to be a tendency to clutch at the mystery surrounding electricity, and assign to it fires which it has never caused in any way. We shall feel relieved to see the matter thoroughly sifted.

St. Pancras Lighting.—The total increase for last year was £15,022, sufficient to clear off the deficit of the first year, £1,543, and after paying all the working expenses and £927 for maintenance, a balance of £4,669 is left, out of which interest and repayment of loan has been met. After Michaelmas the price per unit will be reduced to 5d.

A Grievance against England.—The following Madrid telegram shows that it is impossible for England to be right (according to Spanish ideas), in matters which concern Morocco. It should be some solace to the *Correspondencia de Espana* to remember that, at any rate, the broken down Spanish line was not made or laid by the perfidious race which declines to hand over Gibraltar. "The *Correspondencia de Espana* reports that an uncle of the late Sultan Muley Hassan is intriguing to obtain the Moorish Throne, and that he is supported by the army. Several Madrid newspapers assert that the British cable, the only one now working between Tangier and Europe, in consequence of an interruption of the Spanish line, was monopolised during the whole of Monday night by the telegrams transmitted by the British Minister to the Foreign Office. The journals ask how the interests of other States are to be safeguarded if the British are thus enabled to delay communications other than their own."

NEW COMPANIES REGISTERED.

Telpher Cable and Cliff Railway Syndicate, Limited (41,262).—This company was registered on the 31st ult. with a capital of £6,000, in £10 shares, to purchase, among other things, the concession, lease, and other rights granted to Wm. Jn. Brewer, C.E., authorising the construction of a cable-way across the Dyke at Brighton, and a cliff railway in connection therewith to the "Punch Bowl," and to carry on any business which may seem likely to render profitable the property of the company:—The subscribers (with 1 share each) are: C. A. Walter, 29, Charleville Road, W., brewer; W. G. Croome, 9, Gracechurch Street, E.C., solicitor; S. S. Spink, 87, Newgate Street, E.C., gentleman; C. Tyerman, 81, Gracechurch Street, E.C., gentleman; W. J. Brewer, C.E., 8, Kent House Road, S.E.; T. W. Spink, 87, Newgate Street, E.C., gentleman; J. W. H. Byrne, 81, Gracechurch Street, E.C., chartered accountant. Table "A" mainly applies. Registered by Courtenay Croome, Son & Finch, 9, Gracechurch Street, E.C.

Baird, Thompson & Co., Limited (41,291).—This company was registered on the 5th inst., with a capital of £60,000, in £5 shares, to purchase lands, buildings, plant, &c., and to carry on all businesses connected with the founding and working of iron, brass, and other metals, pneumatic and hydraulic engineering, the destruction of town refuse, electricity and electrical engineering; and to enter into an agreement for the purchase of the business now carried on under the firm of Baird, Thompson & Co. The subscribers (with one share each) are:—Jno. Sturgeon, 11, Heber Road, East Dulwich, S.E., engineer; R. Pollock, 10, Charlton Place, Islington, engineer; J. Mather, 521, Romford Road, Forest Gate, secretary; A. S. Jones, Culverside, Carshalton, civil engineer; T. Atkins, 39, Darrell Road, S.E., civil engineer; J. C. Donague, 49A, Lincoln's Inn Fields, W.C., solicitor; A. W. Marks, 49A, Lincoln's Inn Fields, W.C., solicitor. The first directors are A. B. Crombie, W. Rowley, J. Mather, and J. D. G. Thompson; qualification, 50 shares; remuneration, £350 per year, divisible. Registered office, 159, Queen Victoria Street, E.C.

Cruto Incandescent Lamp Agency, Limited (41,297).—This company was registered on the 5th inst., with a capital of £5,000, in £1 shares, to carry on in the United Kingdom the business of electric lighting in all its branches, electricians and mechanical engineers. The subscribers (with 1 share each) are: J. R. Neate, 11, Oxford and Cambridge Mansions, N.W., accountant; B. F. N. Macrorie, 22, Kennington Oval, S.E., gentleman; W. G. Waterman, 66, Hemingford Road, N., secretary; F. A. Anderson, Lesney House, Erith, chemist; J. W. Luck, 13, Everelda Street, N., commercial traveller; H. S. Kennedy, 69, Tyrwhitt Road, Brockley, shipowner; E. F. Rogers, 14, Trentishoe Mansions, W.C., shipowner. Many of the rules of Table "A" apply. A director's qualification is £50; remuneration not yet determined. Registered office, Dock House, Billiter Street, E.C.

Electrophone, Limited (41,292).—This company was registered on the 5th inst. with a capital of £20,000, in £5 shares, to acquire and take over as a going concern the undertaking of the Electrophone Syndicate, and to buy, sell, and deal in telephones and electricity. The subscribers (with 1 share each) are:—G. H. Culton, 38, Old Broad Street, W., theatrical agent; H. S. J. Booth, 43, Gerrard Street, Soho, merchant; E. H. Baker, 22, Cumberland Terrace, N.W., merchant; D. Davis, 241 to 251, High Street, Boro', S.E., manager; S. Spencer, Castle Brewery, S.E., brewer; H. Hibbert, 15, Great Tower Street, E.C., tea merchant; W. S. Jessurum, 50, Old Broad Street, E.C., merchant. The regulations of Table "A" mainly apply. Registered by H. E. Barnes, 213, Piccadilly, W.

English and Colonial Electric Light Company, Limited (41,336).—This company was registered on the 11th inst. with a capital of £50,000, in £1 shares, to acquire, work, use and dispose of from time to time inventions and devices, patents and patent rights and privileges in connection with electricity, and in particular in connection with the patents, &c., of S. W. Maquay; and to carry on the businesses of electrical engineers and makers of electrical machinery of all kinds. The subscribers (with 1 share each) are:—L. Chalmers, M.E., 72, Bishopsgate Street Within, E.C.; W. Gunn, 2, Crown Hill Road, Harlesden, commission agent; C. T. Kingsford, 103, Campden Hill Road, W., commission agent; W. A. Byron, 12, South Croxted Road, S.E., gentleman; Wm. Chalmers, Sutherland Villa, Wood Green, N., agent; C. Purrott, 31, Wellesley Road, Croydon; F. W. Cartwright, 3, Poet's Corner, Westminster, law stationer. There are never to be fewer than three, nor more than seven directors. Qualification, £100 shares. Remuneration, £100 per annum each. Registered by Marshall & Marshall, 3 and 4, Lincoln's Inn Fields, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

T. L. Hemming & Co., Limited (33,903).—The yearly return of this company, filed April 11th, 1894, shows that out of a nominal capital of £5,000, in £10 shares, 370 shares have been taken up and paid in full, and that 130 shares have been issued as fully paid.

Roger Dawson, Limited (37,901).—The annual return of this company, made up to the 14th ult., shows that out of a nominal capital of £15,000, in £1 shares, 14,993 shares have been issued as fully paid. The full amount has been called and paid on seven shares.

Oswestry Electric Lighting and Power Company, Limited (38,303).—Mr. W. W. Coulson, chartered accountant, of Oswestry, in writing to the Registrar of Joint Stock Companies, says, in regard to the above company, that, pending the granting of a provisional order, no allotment has been made.

Thompson, Ritchie & Co., Limited (35,835).—The annual return of this company has just been filed. It shows that out of a nominal capital of £5,000, in 200 preference and 300 ordinary shares, all of £10 each, the whole of the preference, and 140 ordinary shares have been taken up. The full amount has been called on each share; £1,700 has been received, and an equal amount has been agreed to be considered as paid.

Johannesburg Lighting Company, Limited (35,248).—The annual return of this company, made a week or two since, has been filed at Somerset House. Out of a nominal capital of £150,000, in 50,000 preference and 100,000 ordinary shares of £1 each, all the preference and 77,132 ordinary shares have been taken up. The full amount has been called and paid on seven ordinary shares; the rest have been issued as fully paid.

Electric Trust, Limited (29,191).—This company's annual return, filed on May 3rd last, shows that out of a nominal capital of £60,200, in 6,000 £10, and 200 £1 (founders') shares, 1,675 £10, and 167 £1 shares have been taken up, and that the full amount has been called and paid on each. The sum received is £16,917.

Marshall, Sons & Co., Limited (2,805).—This company's yearly return, filed on the 18th of last month, shows that out of a nominal capital of £400,000, in 10,000 shares of £20 each, and £200,000 of consolidated stock, 2,000 shares have been taken up, that £1 has been called on each, and duly paid. The amount of stock held up to the same date was £200,000.

London Platino-Brazilian Telegraph Company, Limited (12,093).—This company has filed its yearly return, which shows that out of a nominal capital of £400,000, in £10 shares, 37,548 shares have been taken up, and that the full amount has been called on each. The total sum received is £383,480; and £8,000 has been paid on 800 shares forfeited.

Manchester House-to-House Electricity Company, Limited (29,229).—This company's yearly return has just been filed. It shows that out of a nominal capital of £100,000, in 19,900 ordinary and 100 founders' shares, all of £5 each, 107 shares have been taken up. Nothing has been called, and £500 has been agreed to be considered as paid.

Midland House-to-House Electricity Company, Limited (29,230).—This company's yearly return has just been filed, from which we learn that out of a nominal capital of £100,000, in 19,900 ordinary and 100 founders' shares, all of £5 each, 107 shares have been taken up. There has been no call made, and £500 has been agreed to be considered as paid.

Northern House-to-House Electricity Company, Limited (29,231).—This company's yearly return, filed on the 9th ult., shows that out of a nominal capital of £100,000 in £5 shares, 107 shares have been taken up. Nothing has been called, and £500 has been agreed to be considered as paid.

Brazilian Submarine Telegraph Company, Limited (6,886).—The yearly return of this company, filed May 23rd, 1894, shows that out of a nominal capital of £1,300,000 in £10 shares, the whole amount has been taken up, called, and fully paid.

Eastern Extension, Australasia and China Telegraph Company, Limited (7,224).—The annual return of this company shows that out of a nominal capital of £3,000,000 in £10 shares, 250,000 shares have been taken up, called, and fully paid. The amount received is £2,500,000.

BUSINESS NOTICES, &c.

Proposed Electric Lighting at Colchester.—The Lighting Committee have presented a report, received from Mr. W. H. Massey, as to the practicability of supplying electric light for public and private purposes without incurring loss or increasing the rates, and the best course to be adopted for carrying out the provisions of the Colchester electric lighting order. Mr. Massey was of opinion that electric lighting could not be carried on at a profit by a company in Colchester; but it did not follow that the Corporation would fail also, as establishment and working expenses might be reduced to a minimum, if only the various works of the Corporation could be so combined that one staff might assist in running two or more things hitherto kept entirely distinct. At Middle Mill there was water-power sufficient for light day loads and heavy all-night work, but the power would have to be supplemented by steam for heavier loads, and unless the site could be bought very cheaply, the cost of carting coal, and the impossibility of combining any other scheme, and the electric lighting, to say nothing to having to protect the machinery from floods, would run into a considerable amount, and Mr. Massey thought the Corporation had better go elsewhere. At the waterworks site a combined scheme might be arranged so that the steam power could, during the day, be supplied from a new set of boilers common to both undertakings; but they feared complications might arise as to the condensing water. He thought that on the land between the Milk Factory and the Corporation Yard, electric light works might be arranged for, together with apparatus for burning refuse in a manner which would prove advantageous to the ratepayers. The report concluded as follows:—"To provide only for the lighting of North Hill, Head Street and High Street, as far as St. Nicholas Church, by arc lamps, and for the supply of current to about 3,000 40-watt glow lamps out of a total of 4,000 or 5,000 fixed in the houses and shops in these streets, a total expenditure of nearly £13,000 would have to be incurred by the Corporation, and I am quite sure, in my own mind, that if the scheme is limited to this area (the compulsory area of the provisional order), there will be a difficulty in making the electric light pay its way, even in the hands of the Corporation; but if you are willing to take in portions of Crouch Street and St. John Street, of St. Botolph Street and Queen Street, so as to embrace an area in which it is reasonable to suppose 6,000 or 7,000 lamps would be fixed in houses and shops, I estimate that the total expenditure would be about £18,000. To this it would be wise to add £2,000 as working capital, so that a loan of, say, £20,000 would be required. The amount to be set aside for interest and repayment would be £1,100 per year, and the scheme would become self-supporting as soon as a gross yearly rental of £2,000 (including £300 for street lighting) could be obtained." The committee proposed to send a circular to the occupiers of premises situated in a larger area specified. Councillor Thompson Smith moved the adoption of the report, which was carried.

Electricity at Collieries.—Messrs. Ernest Scott and Mountain, Limited, Newcastle-on-Tyne, have recently carried out a most complete colliery installation at Milnwood Colliery, Bellshill, N.B., consisting of the lighting plant for the colliery, the lighting plant for the miners' cottages, and pumping plant for pumping the water from the river. The colliery lighting plant consists of a "Tyne" compound-wound dynamo of a special type, constructed so that it can either be used for the colliery lighting or for the lighting of the miners' cottages. To enable the machine to do this work the field-magnets are wound in a special manner, so that when running the lights at the colliery the machine gives a constant E.M.F., but by switching in an additional coil on the magnet the machine can be used for lighting the lamps at the cottages, and gives a constant pressure at the cottages. The surface is lighted by four of the recently patented arc lamps, working two in series over 100 volts, each giving a light of 2,000 C.P., in addition there are about 100 incandescent lamps distributed about the pit head. For the lighting of the underground about 30 incandescent lamps are used. The installation for the miners' cottages consists of a dynamo, an exact counterpart of the machine used for feeding the lamps at the colliery; the current from the machine is taken to a main switchboard fitted with a double-pole main switch, and then carried overhead by copper conductors suspended upon improved oil insulators. The total length of conductors, out and home, being about 1,500 yards. The 34 cottages are lighted up with 102 16-C.P. lamps, *i.e.*, 3 lamps to each; the lamps in the sitting rooms are fitted with raising and lowering gear, and switches are fitted to each lamp. The pumping plant consists of a "Tyne" shunt-wound dynamo, constructed to give an output of 350 volts and 34 ampères. This machine is fitted, as in the case of the two lighting machines, with sliding bedplates, enabling the slack of the belt to be taken up whilst the dynamo is running. The current from this dynamo is taken to a double-pole main switch, and is then conveyed by overhead cable, the total length being 2,600 yards, to the pumps, which are placed in a pump house by the river.

Gas v. Electricity at Worcester.—A very interesting letter, of which the following is an abstract, appeared in the *Worcester Chronicle* last Saturday from the pen of Mr. W. E. Tucker:—"I have, for the information of my fellow citizens, taken the trouble to work out very carefully the following figures, which I have based on my gas bills for the two corresponding Lady Day quarters of 1893 and 1894. In the summer of 1893 we built a new composing room, and as the Corporation were not prepared with the electric current we arranged with them to hire a dynamo and run the same with our gas engine so as to drive an installation of 30 electric lights of 16 candle-power each. The result is as follows:—For the Lady Day quarter, 1893, our bill was—engine and 68 gas lights, £19 12s., the engine driving six machines. For the Lady Day quarter, 1894, our bill was—engine and 61 gas lights, and 30 electric lights, £20 12s. 5d. The engine driving 10 machines and one dynamo. Taking the hire of dynamo and cost of driving same, the figures work out thus: 68 gas lights cost £10 19s. 11d. for 13 weeks or 3s. 3d. per light per quarter, or about 3d. per light per week. 30-16 candle-power electric lights for 13 weeks cost £3 18s. (including hire of dynamo), or 2s. 7¼d. per light per quarter, or 2¼d. per light per week. Of course we are working at a disadvantage, as we have to pay hire for the dynamo whether used or not, but after a good trial and comparison of both lights on the score of health, cleanliness, purity, and brightness, the electric light is the best."

Canterbury and Electric Lighting.—A meeting of the principal citizens is to be held, in accordance with a recommendation of Mr. A. J. Lardson, the County of London and Brush Provisional Company's engineer, at which Mr. Lardson will explain the position of electric lighting affairs generally. His board have decided that, provided two gentlemen of good financial position and influence in Canterbury or neighbourhood will consent to act as directors of the Canterbury Company, each investing £500 (the directors' qualification under the articles of association), and that a sum of not less than £6,000, and not more than £7,500 of the first issue of shares be subscribed locally, they would be prepared to find twice the amount of the local subscription and proceed with the work within the present year.

Chapel Lighting.—The Chapel Gate Congregationalists at Nottingham are lighting their chapel by electricity as an experiment.

Church Lighting Tenders.—For the electric lighting of Westbourne Park Chapel, Paddington, in accordance with the specification prepared by Mr. J. Wallis Chapman, the following tenders were received:—

	Chapel only.	Front stairs and vestibules.
Messrs. Barham & Sons, Limited, 66, Wigmore Street, W. ...	£367 15 0	... £18 10 0
Messrs. Rashleigh, Phipps & Co., 102, Oxford Street, W. ...	342 0 0	... 21 18 0
Messrs. Belshaw & Co., Victoria Street, S.W.	266 0 0	... 17 0 0
Messrs. Charles J. Grist & Co., 16, Eastcheap, E.C.	230 0 0	... 20 0 0
Messrs. B. Verity & Sons, King Street, Covent Garden ...	174 13 8	... 8 16 0
Messrs. J. G Statter & Co., Victoria Street, S.W.	169 0 0	... 14 18 0
Messrs. Moody Bros., 66, Victoria Street, S.W.	153 12 10	... 16 7 8

These figures are interesting, but the disparity of the tenders is beyond our comprehension.

Leeds Parish Church Lighting.—As stated in our last issue, the contract for the electric lighting of the above church has been let to Messrs. Laing, Wharton & Down, of New Bond Street, London, at £472 19s. The specification and plans have been prepared by Messrs. Shepherd & Watney, consulting engineers, Albion Street, Leeds. The ground floor is lighted by a large number of three-light standards and the galleries by four-light pendants: these are grouped together to suit the requirements of the various services (of which there are at least thirty every week) by twenty-four switches on the main distributing board. Twelve of these switches control one light in each fitting for use during the sermon, the other twelve the remaining lights. Inside the altar rails there are two candelabra of thirteen lights each, and two side lights close to the altar of two lights each. The chancel fittings are of polished brass, and the fittings in the rest of the church of wrought iron. The wires and cables are run under the stone flags of the church in bitumen pipes embedded in concrete, junction boxes being inserted where necessary. The current is supplied by the Yorkshire House-to-House Electricity Company.

Railway Train Lighting.—The London, Brighton, and South Coast Railway Company are reported, says the *Railway World*, to have reached the conclusion that electric lighting for their trains is as satisfactory as either gas or oil. All three systems have been tried upon this line, but the fact that it is not necessary to haul the electrically lighted trains to the lighting station, as is the case with those lighted by gas, appears to tell in favour of electricity. The first cost of gas for a train of ten carriages, including building and apparatus, is given at about £700 per train; oil about £120, and electric light, £400. The expenses with maintenance with gas is about £120 per year per train; with oil from £70 to £130; and with electricity £50. The latter is the average cost obtained from a service on 30 trains.

Roper's Electrical Engineering Company, Limited.—The creditors of the above company are required on or before July 20th, 1894, to send their names and addresses, and the particulars of their debts or claims, and the names and addressess of their solicitors, if any, to Messrs. Neill & Holland, 35, Hustlergate, Bradford, solicitors for William Martello Gray, of Bradford; and, if so required, by notice in writing from the liquidator of the company, are, by their solicitors, to prove their said debts and claims at such time and place as shall be specified in such notice, or in default thereof they will be excluded from the benefit of any distribution made before such debts are proved.

Change of Address.—Mr. William Kingsland, A.I.E.E, has removed from Clarence Buildings, Llandudno, to new and commodious premises at 139, Upper Mostyn Street, where he has a large office and showroom and a convenient workshop, giving much greater facilities for the practical work in all departments of electrical science. Mr. Kingsland and Mr. R. Bellis are pushing on with their scheme for giving Llandudno the benefit of a central electrical supply station, and thus bringing it up to date with other first-class watering places. A strong directorate has been formed, and "The Llandudno Electric Supply Company, Limited," will be registered in a few days.

Electrical Power Storage Company, Limited.—A very neat and handy pocket catalogue for 1894 has been brought out by this company. E.P.S. batteries of the various types are illustrated and described in detail, as are also a number of sundry electrical articles. Facing each page of printed matter is a blank sheet, upon which to make notes. To make the book of a convenient size for the pocket, very small type has had to be used; but it is a credit to the printer that, notwithstanding the smallness of the type, everything is very clear and distinct. We are pleased to recommend the book to the attention of our readers.

Church Lighting at Kelvinside.—St. Bride's Church, Kelvinside, has set the fashion in the district for lighting. Last Sunday night the electric light was used in this church, and already we hear that other churches in the neighbourhood are contemplating following suit.

Leeds Corporation and Electric Lighting.—It is said that the electric light plant in the Leeds Municipal Buildings is to be removed, but whether the Corporation will use their own plant or obtain a supply from the local company has yet to be decided.

Admiralty Contracts.—A return has just been made to Parliament in regard to contracts for articles of home manufacture, made in the United Kingdom, by the several Government departments during the year ended on March 31st, 1894, or contractors outside the United Kingdom. In the Admiralty Department among various contracts, one was made for carbons for electric light, £257. In the War Department there were repairs to telephone receivers, £6. It would seem from this that neither the Admiralty or the War Department are large supporters of the home electrical industry.

Faraday & Son.—This firm have obtained leases of adjoining premises, and the area of their showrooms in Berners Street is now more than doubled. The workshops have been greatly enlarged and fresh plant put down. The foundry, chasing and lacquering shops are further extended, and gilding, silk-shade and pattern-making departments have been added. New rooms for stores, packing, and testing, are part of the same scheme.

Whitehaven Electric Lighting.—The Town and Harbour Trust have decided to reduce the price per unit after July 1st, from 8d. to 5d. It is to be optional whether consumers take a supply at a charge per unit or at a fixed charge at the rate of 30s. per unit per quarter, in addition to a charge by meter of 2d. per unit, as at present, on their agreeing to take a supply by this method for not less than one year.

More Nuisances.—A complaint of a bad smell having been made to the Holywell Local Board, the nuisance inspector made enquiries and somewhat enigmatically reported "that the smell was caused by Mr. Thomas Lloyd, painter and electrical engineer, using paraffin oil to get up steam in his electric machine." Having no remedy the smell has been adopted by the Board.

Business Announcement.—Messrs. H. Binko & Co., electrical engineers, of 34, Leadenhall Street, E.C., have purchased the business and goodwill of the late firm of Ridsdale & Co., and subsequently of H. G. Spurgin, as carried on for many years past at 54, Minories, E.C. All liabilities up to May 26th, 1894, will be paid by the trustee, Mr. Shallis.

Hotel Electric Lighting.—Mr. George Stegmann has received the contract for lighting the "Greyhound" Hotel, Streatham, for which a plant is being put down to supply 145 lights of 16 C.P. He is also lighting the offices of Messrs. Wogan & Co., of 29, Mincing Lane, and Messrs. Hurst & Co., of Fenchurch Station Chambers.

Price Lists.—Messrs. Moeller & Condrup, of Fore Street, have sent us one of their new lists of paraffin-gas-apparatus. The "Aetna" paraffin glow lamp is a new lamp intended for the use of electricians, plumbers, instrument makers, jewellers and others requiring an intensely hot flame. Holding for instance a thick copper wire in its flame, the copper will melt and fall in drops in less than a minute. Two copper wires can be joined simply by holding them together in the flame.

From Messrs. Faraday & Son we have received a list of their "Slashed" shell reflector.

The India Rubber, Gutta Percha and Telegraph Works Company, Limited, have sent us a copy of their May, 1894, list 37, of dynamos. The Silvertown continuous current dynamo of various types is nicely illustrated, and is also priced and described in detail in the list.

Blackburn Lighting.—A Local Government Board has been held with regard to a loan. On the advice of the inspector, the amount applied for has been reduced from £34,000 to £32,000.

School Electric Lighting.—Messrs. Allpress & Co. are now fitting up an electric light installation at the Tonbridge Schools, belonging to the Skinners' Company, at Tonbridge, Kent.

The Lighting of Radcliffe.—The Mayor has impressed upon the Local Board the necessity of supplying electricity in the district, and a Provisional Order will be applied for.

Potential Consumers at Ealing.—The Ealing Local Board are sanguine that the tradesmen of the district will use electricity extensively when the works are finished.

New Works.—Mr. A. C. Baugh, architect, of Wrexham, has received instructions from the Altrincham Company for the erection of their electric light station.

Electric Lighting at St. Annes-on-the-Sea.—There is some talk of the Local Board taking up the matter of electric lighting.

Who'll Buy?—The Acton Local Board want to sell their provisional order; up to the present no one seems disposed to buy.

Worcester and Electric Lighting.—The Corporation have resolved to charge consumers 5d. per unit for current.

Extensions at Dublin.—The extension mains are now being laid.

BOOK RECEIVED.

Development and Transmission of Power from Central Stations, being the Howard Lectures delivered at the Society of Arts in 1893. By W. CAWTHORNE UNWIN, F.R.S. Published by Longmans, Green & Co. Price 10s.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—June 19th. For supply of electric lighting materials for Gordon's College and Gray's School of Art for the Governors. Further particulars will be found in our advertisement pages.

Kingston-upon-Thames.—June 20th. The corporation invite tenders for the construction, supply, and delivery of a gas or oil engine for their electric light station, in accordance with the specification, plan, and form of tender, which can be obtained from Mr. A. H. Preece, 39, Victoria Street, Westminster.

Leeds.—Tenders wanted for fitting up electric light to Builders' Exchange Club, 19, Boar Lane, Leeds. Plans may be seen and particulars obtained from C. Fredk. Wilkinson, architect, 35, Park Square, Leeds.

CLOSED.

London, S.E.—The tender of Messrs. J. G. Statter & Co. has been accepted for the electric crane and generating plant at the works of Messrs. C. H. Glover & Co., Hatcham Saw Mills, S.E., to whom Mr. E. R. Dolby, of Westminster, is acting as consulting electrician.

Paddington.—The following is a list of the tenders submitted for the electric lighting of the female wards of the Paddington Infirmary, to the specification of Mr. A. W. Sclater for the Paddington Board of Guardians:—

Messrs. Lund Brothers	146	0
„ Newton & Co.	159	0
„ Crompton & Co.	143	0
Peter Jones	214	0
D. Bate	156	0
Messrs. Benham & Sons	235	0
„ Pritchetts & Gold	122	10
„ Laing, Wharton & Down	182	11
„ Strode & Co.	167	0
W. Mackie	176	0
Messrs. Peto & Radford	125	0
„ Dawson, Hammond & Co.	135	0
„ New & Mayne	107	0
„ Russell & Co.	139	0
„ Walter Andreae & Co.	175	0
„ Henry F. Joel & Co.	159	9
F. G. Howard	175	0
Messrs. Wenham & Waters, Limited ...	122	0
„ Jarvis & Berry	128	10
„ Harrison, Coles & Co.	210	0
„ E. P. Allam & Co.	184	5
H. Thorpe	284	15
Messrs. Sotheby & Ridout	109	10
„ Girdlestone & Tatham	173	15
„ J. E. Spagnoletti & Crookes * ...	101	13
„ J. W. Carpenter, Limited	146	13
„ Fenton & Barnes	153	0
„ Roger Dawson, Limited	132	0
„ Vaughan & Browne	174	0
„ D. Hewlett & Co.	142	15

* That of Messrs. Spagnoletti & Crookes was accepted.

CITY NOTES.

South Staffordshire Tramways Company, Limited.

AN extraordinary general meeting of this company was held on Tuesday, at the Cannon Street Hotel, E.C., for the purpose of electing directors and auditors.

Mr. W. S. SCHUSTER was voted to the chair, and said that the meeting was purely formal. The petition presented for the winding up of the company, with a view to its reconstruction under the court, was adjourned by Mr. Justice Vaughan Williams to give the shareholders an opportunity of expressing their views upon it. Since then the present directors had signified their intention to retire, in order that a new board might be constituted; and, under those circumstances, the petition would not be proceeded with. The new board, he said, was entirely unfettered so far as regarded the enforcement of claims against the late directors or other persons connected with the company, and its policy would be to come, if possible, to some all-round compromise and arrangement by which the line could be taken out of the hands of the receivers and placed upon a permanent basis. If satisfactory arrangements could not be brought about, the new board would recommend the shareholders to litigate or wind up. Investigations made for the purpose of litigation had thrown a great deal of light upon the history of the company, and it was not proposed, having regard to possible future litigation, to introduce the matter into the meeting, although the fullest information would be given to any shareholder who liked to apply for it privately.

In reply to a SHAREHOLDER, Mr. ELLIOTT said it was probably within the knowledge of the meeting that some time ago a petition was presented for winding up, alleging various acts on the part of the directors and others connected with the company as grounds for so doing; but the judge, after reading the affidavits, said his opinion was that the matters stated in them were not grounds upon which he could order the winding up.

Mr. MUNNS said it was hoped that when the new board was appointed some settlement would be come to with the debenture holders, which would take the line out of their hands, and also with the Electric Construction Corporation, by means of which the charges which the company was liable to pay under the contract would be modified.

Resolutions were then adopted accepting the resignations of the directors, electing Messrs. W. S. Schuster, S. R. Blundstone, and A. Dawson as a new board, and appointing Messrs. Spain and Hardcastle as auditors.

Electro-Chemical Company, Limited.

THE statutory general meeting of this company was held on Tuesday at the Cannon Street Hotel, E.C.

Colonel HOLLAND, C.B., presided, and stated that 16,745 preference shares, representing £83,725, together with 14,000 ordinary shares, representing £70,000, had been allotted, making in the aggregate a total capital of £153,725. Further applications from preference shareholders were still coming in, and were being considered as they were received. The board had ample capital subscribed for all the requirements of the company. The purchase of the company's patents was completed, and they were in course of being transferred to the company. Up to the present time, however, no money had been paid to the vendor, he agreeing to take £25,000 out of the £30,000 to be paid to him in shares. It was proposed at first to lay down machinery to manufacture annually 5,000 tons of caustic soda and bleach. Negotiations were in progress for the sale of some of the foreign patents. They had every reason to believe that by the new process they would be able to manufacture caustic soda at 50 per cent. less than the market price. The patents had been carefully secured to the company.

On the motion of Mr. MARCUS, Colonel Holland's election as a director of the company was confirmed.

After the appointment of auditors a vote of thanks was given to the chairman.

The Electric and General Investment Company, Limited.

THE balance-sheet and profit and loss account for the year ended May 31st, 1894, is as follows:—The profit and loss account shows a gross profit on the transactions of the year (including the balance of £65 16s. 5d. brought forward from last year), of £10,735 6s. 8d., and after deducting all standing charges, and the interim dividend already paid on the ordinary shares, there remains a net balance available for distribution of £7,369 10s. 4d. The directors now recommend the payment of a further dividend upon the capital paid up on the ordinary shares at the rate of 40 per cent. per annum for the past six months, and a dividend on the founders' shares of £30 per share for the year. This will leave a balance of £369 10s. 4d., which the directors recommend should be added in equal moieties to the ordinary and founders' reserve funds. The directors who retire this year are Mr. G. Herring and Mr. B. H. Van Tromp, but being duly eligible, they offer themselves for re-election. The auditors, Messrs. Rait and Kearton, also retire, but offer themselves for re-election.

The Gülcher (New) Electric Light and Power Company, Limited.—An extraordinary general meeting of the shareholders of this company will be held at Winchester House, Old Broad Street, E.C., on Tuesday, June 19th, at 11.30 o'clock in the forenoon, when the subjoined resolutions, which were passed at the extraordinary general meeting of the company held on June 4th, 1894, will be submitted for confirmation as special resolutions:—"That as from the accounts of the company it appears that the company cannot continue to carry on its business by reason of its liabilities, the company be wound up voluntarily." "That Mr. Charles Fitch Kemp, of the firm of Kemp, Ford & Co., 73, Lombard Street, in the City of London, chartered accountants, be appointed liquidator of the company."

Swan United Electric Light Company.—At the meeting held yesterday at Cannon Street Hotel, after Mr. J. S. Forbes had addressed the meeting, the resolution, which appeared in our last issue, winding up the company for the purpose of selling it to the Edison and Swan Company, was unanimously carried.

Stock Exchange Notices.—Application has been made to the Stock Exchange Committee to allow the following security to be quoted in the Official List:—Direct Spanish Telegraph Company, Limited—£30,000 4½ per cent. debentures.

Commercial Cable Company, Limited.—The directors of the Commercial Cable Company have declared a quarterly dividend of 1¾ per cent.

Western Union Telegraph Company.—This company has declared a quarterly dividend of 1¼ per cent.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending June 10th, 1894, amounted to £911; week ending June 11th, 1893, £759; increase, £152; total receipts for half-year, 1894, £20,923 corresponding period, 1893, £20,252; increase, £671.

The Western and Brasilian Telegraph Company, Limited. The receipts for the week ending June 8th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company Limited, were £2,576.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, June 6th.	Closing Quotation, June 13th.	Business done during week ended June 13th, 1894. Highest.	Lowest.
184,500£	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	102 —105	102 —105	...	...
1,134,640£	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	43 — 45	43 — 45	43	...
2,932,680£	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s.	£5 2s.	82 — 83	82½ — 83½	83	81
2,932,680£	Do. do. Defd.	Stock	...	...	...	7¾ — 8¼	7½ — 8	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½ % §	6½ % §	12 — 12½	12 — 12½	12½	12 5/16
18,700£	Do. do. 5 % Bonds	100	...	...	...	100 —103	101 —104	...	...
75,000£	Do. do. 5 %, repayable June 1906	100	...	...	...	108 —112	109 —113	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10 % ‖ §	... §	1½ — 2½	1½ — 2½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	140 —145	140 —145	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3 1/16 % §	2 % §	2 % §	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12 — 13	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18 — 19	18 — 19	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½ %	4 %	4 %	3¾ — 4¼	4 — 4½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9 — 9½	9 — 9½	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½ % §	3½ % §	...	9¾ — 10¼	9¾ — 10¼	10 1/16	9 7/8
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½ % §	6½ % §	...	14⅛ — 15⅛	15 — 15¼	15 3/16	14 1/4
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	15¾ — 16¼	15¾ — 16¼	16¼	16 3/16
105,900£	Do. 5 % Debs., repay. August, 1899	100	...	...	...	107 —110	107 —110	...	...
1,294,100£	Do. 4 % Mort. Deb.	Stock	...	...	...	113 —116	113 —116	115	114
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15½ — 15¾	15⅝ — 15⅞	15⅞	15⅝
62,700£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	104 —107	105 —108	...	...
222,800£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	104 —107	105 —108	...	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	114 —117	114 —118	117	115½
95,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	104 —107	105 —108	...	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	104 —107	105 —108	..	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	104 —107	105 —108	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	106 —109%	107 —110%	107	...
180,227	Globe Telegraph and Trust, Ltd.	10	5⅛ % §	4⅞ % §	4⅝ % §	8¼ — 9⅛	9 — 9¼	9⅛	9
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15½ — 15½	15⅝ — 15⅝	15 9/16	15½
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜ % §	8⅜ % §	8⅜ % §	21 — 21½	21 — 21½	21⅜	21
200,000£	Do. do. do. 5 % Debs.	100	...	...	...	104 —107	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	43 — 45	43 — 45	45	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	4 — 6	5 — 7	...	...
100,000£	Do. do. 6 % Debs.	100	...	...	...	106 —109	107 —110	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	½ — 1½	½ — 1½	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4⅞ — 5⅛	4⅞ — 5⅛	5⅛	4 15/16
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	15 — 16	15 — 16	15	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14½ — 15½	14½ — 15½	14 13/16	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5½ — 5¾	5½ — 5¾	5 11/16	5⅝
925,017£	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	115 —117	115 —117	115	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	1/32 — 1/16	1/32 — 1/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	102 —105	103 —106	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	5 — 6	5 — 6	...	...
3,381	Submarine Cables Trust	Cert	...	...	...	113 —118	112 —117	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1½ — 2	1½ — 2	...	...
146,370£	Do. do. 5 % Debs.	Stock	...	...	...	90 —100	90 —100	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900£	Do. do. do. 5 % Debs.	100	...	...	...	101 —104	102 —105	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2½ — 3	2½ — 3	...	...
150,00 £	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	100 —105	100 —105	...	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½ %	5 %	7½ — 7¾xd	6¾ — 7¼	...	...
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	6¼ — 6¾xd	6 — 6½	...	...
33,129	Do. do. do. 5 % Def. ...	7½	3 %	...	...	2 — 2½	2 — 2½	2	...
178,200£	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	106 —109	1 7 —110	...	...
222,700£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	106 —109	107 —110	...	...
88,321	West India and Panama Teleg., Ltd.	10	¾ %	¾ %	¾ %	1⅛ — 1⅜	1⅛ — 1⅜	...	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10¼ — 10¾	10¼ — 10¾	10 5/16	10½
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	9 — 10	9 — 10	...	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	109 —112	109 —112	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	110 —115	110 —115	...	...
169,000£	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½ %	4½ — 5½	4½ — 5½	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,000—180,000	10	...	...	...	12 — 13	12 — 13	12¾	...
20,000	Do. do. 6 % Cum. Pref., 1 to 20,000	10	...	6 %	6 %	13½ — 14	13½ — 14	13 1/16	13 1/16
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) £75 paid	...	...	...	...	83 — 85	84 — 86	85	84¼
19,900	*Electy. Supply Co. of Spain, 101 to 20,000...	5	...	...	...	... ...	... ...	...	...
45,000	†Liverpool Electric Supply, £4 10s. paid	5	4½ %	5 %	5 %	6⅜ — 6½	6⅜ — 6½	...	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	2½ %	8 — 8½	8¼ — 8⅜	8⅜	8⅜
100,000£	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	107 —110 xd	107 — 110	109	108½
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4½ — 5½	4½ — 5½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½ %	7¼ %	4½ %	6¾ — 7¼	7 — 7½	7⅛	7⅛
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 8½	8¼ — 8⅜	8½	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½ %	4 %	6¼ — 6⅝	6¼ — 6⅝	6⅝	6¼

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, June 6th.	Closing Quotation, June 13.	Business done during week ended June 13th, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅝ — 3	2⅝ — 3	3	2⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2⅛ — 2⅜	2⅛ — 2⅜	...	...
125,000/	Do. do. 4½ % Deb.	Stock	...	...	...	108 —111	108 —111	...	...
630,000/	City and South London Railway	Stock	...	⅝%	⅝%	36 — 38	36 — 38	...	...
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 % §	7 % §	7 % §	3 — 3½	3 — 3½	...	...
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	95 —100	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	¼ — ⅜	¼ — ⅜	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½ — 1⅝	1½ — 1⅝	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750 ...	2	*nil*	*nil*	*nil*	¼ — ⅜	¼ — ⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1½ — 1⅝	1½ — 1⅝	1½	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	1 — 1¼	⅞ — 1⅛	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½ — 1½	½ — 1½	...	...
9,600/	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½ — 7½	6½ — 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd, Ord.	10	5 %	5 %	5 %	6½ — 7½	6½ — 7½	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	23 — 24	23¾	23½
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	103 —105	103 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	8 7/8 — 8 9/16	8⅛ — 8½	8¾	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	12¾ — 13¼	12¾ — 13¼	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	2 — 2½	2 — 2½	2⅜	2
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	39 — 41	39 — 41	41	40
150,000/	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	104 —107	104—107	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅜.
Electric Construction Corporation, 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
Electricity Supply Corporation, Ordinary of £5, 5—5¼.
House-to-House Company (£5 paid), 1—1½.
Do. do. 7 % Preference, of £5, 5¼—5½.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅜—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅞.
Liverpool Electric Supply, £5 (fully paid), 6½—6⅝.
Do. do. £3 10s. paid, 4½—4⅝.
London Electric Supply Corporation, £5 Ordinary, ⅞—1¼.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

ARE WORKMEN DETERIORATING?

It is a common complaint that the workman of to-day cannot compare with his predecessor of 50 years ago, and to a very great extent this is, we regretfully believe, true. It is not that the engineering work of to-day is, on the whole, inferior to that of our forefathers, for the improvement in machine tools has rendered possible an exactness and finish that would, without such tools, be impossible, and thus the combined result of man and machine is probably better, while all the time the man has been degenerating from the position of an engineer to that of a mere machine tool attendant with little handicraft in him and less power of intelligent reasoning. To-day a steam engine is sent out in a supposed finished state, requiring little else but setting on a level foundation by a man who can use a nut wrench. In the olden days an engine went out half made, and had to be set up on a rough stone bed which was dressed until it carried the cast-iron engine bed truly level. It was not even allowed to wedge the bed-plate level and grout up beneath it. In many other ways too, much remained to be done by the erector who was away from head-quarters, and relied on his own resources for everything, and when the engine was complete it was his duty to start it and leave it in order, bringing home a satisfactory indicator card as evidence that the valves were right and a satisfactory vacuum was being obtained. All this seems to be a thing of the past, and we are very much inclined to think that much of the blame for present inferiority lies on the shoulders of the employers who, in the first place, do not have apprentices taught their business, and do not allow men, or even expect men, to exercise even ordinary common sense in carrying out work away from home. An instance of the sort of thing we mean came directly under our notice quite recently in London which may be placed on record. A new compound engine was being started by the men who had erected it for the makers, one of the principal firms of engine builders in the country. The valve gear was one of the numerous modifications of the detent and release action, similar to the Corliss detent motion automatically variable on the first cylinder, but variable only by hand on the low pressure cylinder. Upon the eccentric rod continuation there was a right and left screw sleeve for adjustment. Upon starting the engine we noticed that the adjustment was wrong, so that one of the low pressure valves did not move its detent, not moving far enough to engage by about $\frac{1}{100}$th of an inch. At the other end of the cylinder the detent overran about $\frac{1}{16}$th of an inch, showing that the adjusting rod required to be shortened to effect about $\frac{1}{32}$nd of an inch at the detents. The fault was pointed out to the erector, who first declared it was all right; he would not see that the one end only of the large cylinder was receiving steam, but, finally, he declared that his people would not allow him to make the alteration. The office was communicated with and asked to send some one authorised to make good the defect, and a start arranged later in the day. The request was ignored, and so a high class engine, by a big firm, was run in this lame condition, which could have been remedied in a few seconds with a spanner while the engine was running, and several people wasted valuable time over a paltry want of an adjustment that any apprentice of 20 years ago would have been authorised to effect. We hardly think it redounds to the credit of the engine makers to send out men to erect their engines who are not supposed to be trusted to make such a necessary but simple rectification of a glaring defect. What would have been the result had the engine been sent to France to erect—would the firm's erector have required to telegraph home, "Crank pin red hot, may I stop the engine?" or, "Furnace crowns coming down, send permission to clear out;" and yet these are little less foolish than refusing permission to set the engine valves to work. Unless a firm of engineers can positively guarantee perfection in their work, it is folly to make hard and fast rules of the sort we have encountered. It makes the workmen look exceedingly foolish in the eyes of such bystanders as can see when

an engine is right or wrong, and is apt to lead, as in the case in point, to an attempted wrong explanation in hopes that the enquirer's knowledge goes no further than the surface. This method of doing business may be new: it is not the method which was in vogue when English steam engines were being erected all over Europe by men who worked practically free of head quarters, and often remained to occupy responsible positions; and we scarcely think that, without some change in the general training of apprentices, the quality of work will be maintained, for there will be no men to put up machinery as it should be put up, and no amount of excellence of shopwork can make up for incorrectly erected machinery. Something more than the mere mechanical skill to set up level and square is required.

THE PACIFIC CABLE.

The following further letters have passed between Sir Charles Tupper and Sir John Pender:—

Winchester House, Old Broad Street, E.C., May 30th.

Dear Sir Charles Tupper,—Absence from home has alone prevented me from replying to your letter of the 17th instant earlier.

First,—Permit me to point out that although it be true that certain of the Australasian Governments have from time to time granted subsidies and guarantees to the Eastern Extension Telegraph Company, my statement that telegraphic communication with Australia was established solely by private enterprise is quite accurate, the subsidies and guarantees having been given for specific purposes other than the establishment of the communication. For instance, the subsidies were granted to enable the company to duplicate the Australian section of the line, not because it was unequal to the traffic requirements, but because the Governments and telegraphing public had found to their cost that no confidence could be placed in a single line, and, as my experience fully bears out this view, I contend that if a Pacific cable is to afford the same measure of security as the existing system it must be duplicated. The guarantees were granted, as you are aware, to obtain the substantial reduction of tariff from 9s. 4d. to 4s. per word.

Secondly,—Your reference to the Berne list as your authority for stating that the Eastern Extension Company's original cables, although more than 20 years old, were still in working order, explains how you have been misled in the matter, the list only giving the dates when the early cables were first laid with their respective lengths, without showing the extensive cable renewals which have since been found necessary.

Thirdly,—As to the question of monopoly, I find on looking through the official report of the Colonial Conference (1887) that the remarks attributed to the late Mr. Raikes really referred to the following paragraph of a paper which Mr. Sandford Fleming read to the conference immediately before Mr. Raikes addressed the delegates, namely:—

"Mr. Pender submits that the existing company (Eastern Extension Company), as the pioneer of telegraphic communication with Australia, is entitled to a large share of consideration at the hands of the colonies."

Consequently to represent this perfectly reasonable contention as a claim to a monopoly is simply absurd.

But none of these points have any important bearing on the real question at issue—namely, is the proposed Pacific cable an undertaking which can be recommended to the investing public?

The Pacific cable project, as I understand it, is as follows:—

It is proposed to lay a single line of cable connecting Canada with Australia at a cost of £1,800,000, and in order to raise this sum guarantees for 14 years from the several Governments supposed to be interested to the amount of £72,000 per annum are to be obtained.

Now let us examine this proposal from the point of view of an intending investor:—

Capital		£1,800,000
Working expenses	£25,000	
Maintenance	35,000	
		£60,000*
(*Note.—This is Mr. Sandford Fleming's own calculation.)		
Amortisation to replace capital at end of 14 years' guarantee	105,000	
		£165,000
Less earnings estimated on basis of one-half of the Eastern Extension Company's receipts from the Australasian traffic	£45,000	
Four per Cent. Guarantee	72,000	
		£117,000
Leaving an actual loss to investors of		£48,000 per ann.

Suppose, for the sake of argument, we assume that the Pacific cable might one way or another obtain as much as the whole of the Eastern Extension Company's present Australasian receipts, even then there would be absolutely no return on the capital invested, and if the Pacific cable were duplicated the loss would probably amount to £120,000 per annum.

The above figures will, I am sure, be regarded by all conversant with the expenses attending the working and maintenance of cables laid in deep seas as not only moderate, but rather under the mark, for it must not be overlooked that no allowance is made for a prolonged interruption, a contingency which is very probable to a single cable laid in such extreme depths as have been proved to exist in the Pacific, and during which interruption the guarantees would, of course, cease to be paid.

I observe with some surprise that you quote with approval an article which appeared in the *Globe*. It is evident that the writer knows very little of the subject, for he says in case of the cables between Aden and England being injured all communication with India would be interrupted. As a matter of fact, no fewer than three other routes practically under the control of the existing system would still be open for traffic.

Again, I fail to understand on what grounds the writer holds that a single line of cable nearly 9,000 nautical miles in length laid in the Pacific should stand less chance of interruption than the existing cables.

With such figures as I have above placed before you, and which, as a director of a submarine cable company you can fully appreciate, I would ask whether you would consider yourself justified in putting your name to a prospectus inviting subscriptions from the public for a scheme showing such disastrous financial results, even with the aid of the suggested Government guarantees.

I remain yours faithfully,

John Pender.

Office of the High Commissioner for Canada,
17, Victoria Street, London, E.C., June 4th, 1894.

Dear Sir John Pender,—In reply to your letter of May 30th, I beg to remind you that we joined issue on the following points:—

1st. Whether the "existing service was established solely by private enterprise."

2nd. Whether the life of a cable is 14 years.

3rd. Your assertion that my "description of the existing system as a monopoly cannot be justified."

4th. That a Pacific cable has no strategic value.

I respectfully submit that the admission that the "existing service" has already received Government subsidies exceeding £2,000,000 settles the first issue.

You reject the authority of the Berne list, for the accuracy of which I supposed you were responsible, quoted by me in support of my contention as to the life of a cable, but you have not met my quotation from a recent speech of your own, which showed the life of a cable to be nearer 25 years. Permit me to quote the further evidence of another high authority on that question—your late colleague Sir James Anderson, who was knighted for laying the first successful cable between England and America. In October, 1886, at a meeting of the Direct Spanish Telegraph Company, Sir James Anderson, presiding, said:—"They estimated the life of the Barcelona cable at 25 years." It had then been in operation 13 years, and great improvements have been made in the manufacture of cables since the Barcelona cable was constructed. I think I may now fairly consider the second part of our controversy disposed of.

As to the "monopoly" question, you intimate that Mr. Raikes was misled by Mr. Fleming. I will now give you an authority which I am sure you will respect, for it is your own. I find the following statements in a letter written by you to Sir Henry Holland, dated April 18th, 1887:—"If reference is made in any way to the existing companies as a monopoly, my answer is that it has been so created by the great energy with which the company have carried on their extensions. . . . I would also draw your attention to the fact that while it has been made a monopoly through the circumstances I have stated," &c. While this public record remains you will, I imagine, hardly repeat the statement that I am not justified in considering the "existing system as a monopoly."

As to the question of the strategic value of a Pacific cable, not only the *Globe*, from which I quoted, but the Press, generally of this country, of Australasia, and Canada have been emphatic in their declarations in opposition to your views, nor can I see how any disinterested man can hold any other opinion. The cable communication between this country and India and Australasia passes through several foreign countries, and in the contingency of a European war could not be relied on.

You say, in reply to the statement in the *Globe*, that in the case of your cable between Aden and Bombay being injured, communication with India would be interrupted, that you have three other routes practically under your control. I suppose the three routes you refer to are those given in the official maps of the International Bureau:—

1st. Through Russia, Siberia, Japan, and China.

2nd. Through Germany, Russia, and Persia to Kurrachee.

3rd. Through Constantinople and the Euphrates Valley to Kurrachee.

I am not aware that these long overland lines are under the control of the Eastern Telegraph Company.

For Imperial purposes the first and second routes present insuperable difficulties, and I do not think that your experience in telegraphy with India will lead you to consider as reliable the Euphrates Valley line, which belongs to the Turkish Government and passes through a country bristling with physical difficulties, rendering the maintenance of good communication almost impossible. You must, however, admit that, if the Indian land wires in the neighbourhood of Kurrachee and Bombay were interrupted, all communication by telegraph between these towns and Calcutta, Madras, and Australia would require to be transmitted to Europe for re-transmission through the only remaining route open to the East—viz., through Russia, Siberia, Japan and China. An all-British line, *via* Canada, to Australia, remote from any hostile influence, might, at any moment, therefore, become vital to the best interests of the Empire. As to the financial

prospects of this enterprise, I am glad to find that you have revised the estimate you submitted to Lord Ripon in April, and now make the deficit £48,000 instead of £120,000, at which you then stated it. I beg to suggest that if you will place the amortisation of the cable at 25 years, and add the receipts of the large volume of United States and Canadian traffic that will be created by a Pacific cable, and make fair allowance for the usual increase of traffic, your latest calculation will be considerably modified. Allow me to add that your adherence to 14 years as the life of the cable in order to show the scheme to be financially impracticable will, in my opinion, convince many persons that the enterprise cannot be condemned by fair calculations.

I remain yours faithfully,

CHARLES TUPPER.

Sir John Pender, G.C.M.G., M.P.

Winchester House, 50, Old Broad Street, London, E.C.,
June 6th, 1894.

Dear Sir Charles Tupper,—I have received your letter of the 4th inst., from which it is quite clear that our views on the Pacific cable question are so divergent that no practical purpose will be served by continuing the correspondence any longer.

But before closing it permit me to briefly deal with the principal points raised in your last letter, and to express the hope that the facts and figures which have been elicited by the correspondence may be found useful to the Ottawa Conference, and more particularly to the investing public, who will eventually have to decide the question if it is to take a practical shape.

With regard to the first point, I think any unprejudiced person reading my previous letter will have been convinced that the pioneer service to Australia was established solely by private enterprise, and that the Government subsidies granted years afterwards for an entirely different purpose have no bearing on the argument.

As to the second point, it is true that there are cables still working which were laid 25 years ago; but, on the other hand, many cables equally well manufactured and laid have been known to require entire renewal in as short a time as 12 to 17 years after they were submerged. In short, the life of a cable is notoriously uncertain, depending very largely on the locality and nature of the bottom over which it is laid, and it is therefore impossible to accurately measure such an unknown quantity. I have never, however, asserted that a Pacific cable would last only 14 years. All I have done is to base my calculation for amortisation on the period fixed by the Wellington Conference for the proposed guarantee—viz., 14 years.

If, however, we take 20 years, which is the more usual period for subsidy or guarantee arrangements of this kind, as the basis of calculation, the financial result to an investor would still be most disappointing, as shown by the following figures:—

Capital, £1,800,000.		
Working expenses	£25,000	
Maintenance	35,000	
	£60,000	
Amortisation to replace capital at the end of 20 years	67,000	
		£127,000
Less earnings estimated on basis of one-half existing traffic	£45,000	
Four per cent. guarantee	72,000	
		£117,000
Leaving an actual loss to investors of		£10,000

And if the Pacific cable were duplicated, which I contend would be absolutely necessary to make it a successful competitor to the existing system, the loss would, of course, be immensely greater.

When writing to Sir Henry Holland the letter to which you refer, I was endeavouring to meet objections raised by opponents to the strong position which we had built up, and which had been described as a monopoly. As a matter of fact, our control of the Australian traffic has never depended on the possession of exclusive privileges, which alone would constitute a monopoly in the strict sense of the word, but it has been the result of good business-like work, carried out on strictly economical principles.

As to the strategic question, I can only express surprise that you should think a Pacific cable would be safer in time of war than the existing cables which follow the principal trade routes, where British war vessels would presumably be found in far greater force than in such a remote region as the Pacific Ocean.

The three alternative routes which I had in mind when referring to the *Globe* article were:—

1. The cables from England to Aden round the coast of Africa.
2. The Indo-European Company's system.
3. The Great Northern Company's system.

With the Indo-European and the Great Northern Companies we have working agreements, and the first-named route is, to a large extent, owned by the Eastern Company.

With regard to your last point, the only difference between the figures submitted to Lord Ripon and those given in my letter of the 30th ult. is that in the one case the deficit includes 4 per cent. interest on capital, and in the other the deficit is shown without interest. But the practical result to an investor is precisely the same, and with such figures before you I would again ask whether you would be prepared to put your name to a prospectus inviting subscriptions from the public for such an unprofitable scheme.

Having now answered your letter the correspondence must cease, as your time and mine is much too valuable to be taken up with an academic discuss on of this kind. If, however, the question should take a more definite shape, I shall be happy to resume this discussion with a view to arriving, if possible, at a practical result.

Yours faithfully,

JOHN PENDER.

To the Hon. Sir Charles Tupper, Bart.,
G.C.M.G., C.B.

Office of the High Commissioner for Canada,
17, Victoria Street, London, S.W., June 8th.

Dear Sir John Pender,—I am not surprised to find by your letter of the 6th inst. that you wish to close the correspondence which you initiated, and I cannot help thinking that those who have followed it will wonder why it was ever commenced. I am quite satisfied to leave all the questions at issue to the judgment of the public. Your admission that the "existing service" has already received over £2,000,000 of Government subsidies; that the life of a cable may fairly be estimated at 20 years; and that you are responsible for the statement that the existing service to Australasia is a "monopoly" is very satisfactory to me. I am also glad that I have been able to induce you again to revise your estimate. In reply to your question I venture to suggest that capitalists will not be influenced in this matter by your opinion or mine, as their decision will depend upon the action of the Governments of the United Kingdom, Australasia, and Canada.

Yours faithfully,

CHARLES TUPPER.

Sir John Pender, G.C.M.G., M.P.

SOME REMARKS ON POWER DISTRIBUTION BY ELECTRICITY, WATER, AND GAS.*

BY MR. ED. C. DE SEGUNDO.

In fixing on a title for this paper, the author found it impossible to convey the exact scope of the subject the author wished to discuss, without making the title extremely long, and he therefore chose a title of reasonable length which most nearly conveyed his meaning, trusting that he would be allowed to explain it in a few words before commencing his argument.

For some time past the author has been struck by the great discrepancy between theory and practice that must exist in the working of electric generating plant in central supply stations where steam is used. Observation and experience alike have served to accentuate the inefficiency of electric generating plant, and some rough comparisons made with other modes of producing and distributing power have led him to go into the matter more carefully, and when invited by Mr. Worby-Beaumont to contribute a paper to your Society, he not only felt honoured at such a request, but was glad of an opportunity of bringing this matter before engineers for discussion. Such a subject as the distribution of power admits of practically endless elaboration. Moreover, nothing can be gained by generalisations from the results of existing or proposed distributing systems. The proper value of each system is entirely conditioned by the initial form in which energy is available, and by the final form in which it is required.

As one of the most important developments of modern engineering lies in the application of electrical energy to lighting, this latter will be considered as the final required form of energy, and coal will be taken as the initial form in which energy is available. These conditions apply to nearly all large towns.

In the following lines, the author proposes briefly to consider:—

1. The efficiency of electric generating plant in central stations at the present day.
2. The efficiency of power producing plant in hydraulic power stations.
3. The efficiency of gas engines for production of power.

The definitions of efficiency are probably more numerous, even, than those of "load factor," and no doubt the ingenuity of that class of investigator which seeks to make a labour of investigation is not yet exhausted in the direction of finding out new possible ratios; but in such a paper as this, which is designed more to suggest a line for discussion than to deal with any discoveries or startling novelties, it is well to briefly consider which definition of efficiency is best calculated to serve the purpose of this paper.

The efficiency with which the practical engineer has to deal may be expressed—perhaps with brutal matter of fact-ness—as the ratio of what you get to what you pay for. But while such definition expresses the main value of a combination of machines commercially, it is not a convenient ratio for comparison with other similar ratios, because the introduction of market value at once destroys the possibility of bringing each fraction to a common denominator. As the motors that will be considered to-night are all heat machines, the author proposes to base his comparisons upon the ratio of the thermal equivalent of useful work available for commercial purposes to the calorific value of the fuel burnt per hour. Such considerations as the cost of fuel can easily be applied after.

This definition, however, is open to the objection that it is not fair. It may be argued that if a heat machine of necessity rejects a large proportion of the heat it receives, it is not just to calculate an estimate of efficiency upon a basis which is impossible of realisation

* Read before the Society of Engineers on Monday, June 4th, 1894.

and that the efficiency should be expressed by the ratio of useful work to maximum possible useful work in that class of heat machine. The author would submit that while such a contention bears the semblance of justification, it should be borne in mind (1) that the fact of a machine necessarily rejecting a large proportion of the heat received cannot be pleaded as a valid reason why such a proportion of heat should be rendered unavailable, (2) that the definition adopted by the author gives an absolute basis for comparison, (3) that as long as the meaning attached to the word efficiency is quite clearly understood, it can make no difference to the argument if the actual, instead of the ratio of the actual to maximum theoretical efficiency is used, (4) that the latter is merely one of the very numerous definitions of efficiency.

A steam engine is usually accounted an extremely wasteful heat machine, but this is, strictly speaking, not the case.

The only way to increase the efficiency of the steam engine is by lowering the lower limit of temperature, but directly efforts are made in this direction a limit is soon reached, beyond which further lowering of the temperature not only ceases to be productive of any good, but is productive of evil. In short, it may be said that all the heat developed in the combustion of fuel is utilised by the steam engine, either in doing work, or in providing the means of doing work or controlling the rate at which work is done.

The efficiency of the steam engine and boiler combined is not difficult to determine; it is the ratio of the thermal value of the brake horse-power hour to the calorific value of the fuel consumed per brake horse-power hour.

The efficiency of the gas engine and its equivalent of steam boiler requires some investigation.

A ton of coal, according to Mr. Emerson Dowson, may be taken to produce 9,500 cubic feet of gas, and 1,500 lbs. of coke, of which about 400 lbs. will be consumed under the retort. Assuming that coal having a calorific value of 14,000 thermal units per lb. is used, and taking the calorific value of coke at 10,000 thermal units, the number of thermal units liberated from the ton of coal is (neglecting heat necessary to raise the mass of coal to the temperature of the retort), $2,240 \times 14,000 - 1,500 \times 10,000$, or 16,360,000 thermal units. Of the heat developed by the consumption of the coke under the retort, a large proportion can never be expected to reappear in the gas. But 16,360,000 thermal units have actually disappeared in producing 9,500 cubic feet of gas, hence, $\frac{16,360,000}{9,500}$ or 1,722 thermal units should be accounted for per cublic foot of gas.

Prof. Kennedy, Prof. Unwin, and others, have made calculations of the calorific value of a cubic foot of gas, the results of which agree fairly. The average calorific value of London gas may be taken as 620 thermal units per cubic foot at 55° Fahr., and at a pressure of 14·7 lbs. per square inch, hence the efficiency of the gas generator is

$$\frac{620}{1,722} = \text{about } 35 \text{ per cent.}$$

The function of a steam boiler is, in the case of the gas engine, split up into two, one portion is done at the gas works, and the remainder in the cylinder of the engine itself. Now about 24 per cent. of the heat given to a gas engine is turned into indicated power, or in the case of a large sized engine, about 20 per cent. is converted into brake horse-power. Hence the real efficiency of the gas engine and boiler, so to speak, is about 7 per cent. The efficiency of a non-condensing steam engine, consuming 2 lbs. of coal of a calorific value of 14,500 thermal units, and working at 80 per cent. mechanical efficiency, is 8·72 per cent., so that the total efficiency of one machine is very much the same as that of the other, on this basis of argument, But Mr. Dowson claims to produce one brake horse-power hour for 1 lb. of anthracite, by using his generator gas. This (taking the calorific value of anthracite at 16,000 thermal units per lb.) would correspond to a total efficiency of nearly 20 per cent., an efficiency which the steam engine and boiler can never hope to reach.

Although the author desires to consider the two heat machines on the basis of what may be termed the useful efficiency, namely, the ratio of available power or brake power to power equivalent of fuel burnt, still in the face of so great a difference as the foregoing, it may be of interest to enquire into the reason of the difference, and to do this it is necessary to consider another efficiency, namely, the ratio of heat turned into work in the cylinder, to the maximum theoretically possible. This latter quality is expressed by Carnot's law as the ratio of the difference of temperature at which heat is received and rejected to the absolute temperature at which the heat is received. In the case of the steam engine this ratio is not difficult to determine, because the heat is all received at one temperature, and rejected at one temperature. But in the case of the gas engine this is not so. As mentioned before, part of the function of the boiler, or part of the operation of calling into existence the working fluid whereby heat energy may be transformed into mechanical energy, is performed in the cylinder of the engine itself. This operation cannot be instantaneous, in obedience to physical laws, therefore the heat is received during an appreciable interval of time and at temperatures varying from the temperature of the mixture and the end of compression to the maximum temperature reached by the charge after explosion. In some parts of the cylinder this temperature may, according to Mr. Clerk, be as high as 3,400° F. It would appear, however, that most authorities agree upon 2,700° F. as about the maximum temperature reached by the charge in gas engines of all forms.

The temperature of the discharged products is not far short of 800° F., though of course the heat rejected is not rejected at one temperature. Hence the maximum efficiency attainable should be

$$\frac{2,700 - 800}{3,160} = \frac{1,900}{3,160} = 60 \text{ per cent.}$$

The efficiency of the non-condensing steam engine cylinder under an admission pressure of 130 lbs. per square inch and an exhaust pressure of 20 lbs. per square inch would be about 18 per cent. Therefore if this steam engine turns 8 per cent. of the heat into work, it is doing as well relatively to its peculiar limitations as the gas engine that turns 26 per cent. of the total heat received into work.

The greater useful efficiency of the gas engine, therefore, must be ascribed to the nature of the vehicle used for carrying the heat, and not to the superiority of the gas engine as a heat machine.

The great faults of the gas engine are (1) the enormous heat lost in the cooling effects of the cylinder jackets (sometimes over 50 per cent. of the total heat), and (2) the high temperature of the exhaust products.

It is not within the scope of this paper to even suggest any direction in which the efficiency of the gas engine might be enhanced, but it is obvious that if the link could be forged between the now disconnected heat chain in the gas engine cycle, whereby the heat carried away in keeping down the temperature of the cylinder could be usefully expended in some other part of the cycle, the time would not be far distant that Sir Frederick Bramwell has spoken of, when all that remains of the steam engine would be a working model or two in some obscure museum.

Let us now consider an electric generating plant using steam power.

Tests of various portions of electric generating plant are continually being published which, if they are any criterion of what may be attained in practice would point to an extremely high efficiency of a generating station as a whole. Any dynamo manufacturer would be much insulted if one were to suggest that his 30 kilowatt machine would not yield a commercial efficiency of over 90 per cent. at anything like full load. The makers of high speed, non-compound, non-condensing engines claim a mechanical efficiency of something like 90 per cent., with a steam consumption of 18 lbs. 1 H.P. hour, or 20 lbs. per brake horse-power hour, and moreover they are always prepared to prove it.

Only a few weeks ago Messrs. Siemens published an account of a test of a steam dynamo driven by a Willans engine, which resulted in a combined efficiency of 88 per cent. It is also possible to obtain boilers which will evaporate over 12 lbs. of water from, and at 212° F. per pound of good coal. Now it may be interesting to compare the best possible results based upon such efficiencies. Take a pound of coal whose calorific value is, say, 14,500 thermal units. The author is given to understand that certain boilers in one of the electric generating stations in London evaporate 12·8 lbs. of water from, and at 212° per pound of coal. This would correspond to an efficiency of about 75 per cent. Allowing 30 per cent. for loss in transmission and radiation, and 13 per cent. as the highest thermal efficiency of a non-condensing, high speed steam engine, using 18 lbs. of water per indicated horse-power hour, this would leave 1,372 thermal units turned into work in the cylinder of the engine.

Taking 88 per cent. as the efficiency at which a steam dynamo was recently described to be capable of working, 1,207 thermal units, or nearly 350 watt hours should reappear at the dynamo terminals, and subtracting 10 per cent. for loss in distribution, 315 watt hours should be paid for by the consumer per pound of coal burnt at the station. This is equivalent to a consumption $\frac{1,000}{350} = 2·86$ lbs. of coal per unit delivered.

Were a full load to be maintained at a generating station, this result is what should be realised if the efficiencies claimed for the various factors are trustworthy. But nothing approaching this figure is attained in central station work, and the whole of the discrepancy is attributable to the influence of a load factor. In all, eight definitions have been given of the term load factor. In the considerations under review the author takes the following definition, namely, the ratio of total output to safe maximum output for which the plant is designed. It will be interesting to compare existing practice with the result obtained by assuming efficiencies, &c., which may be reasonably considered to accompany the working of a plant under the ordinary working conditions in England.

In a modern generating station the sizes of the generating units should be so proportioned, and the general arrangements so designed, as to enable a careful man to keep the load on those of his units which are running at a minimum of from 50 to 60 per cent. of full load. This means that on the average the units in work will run at something considerably over half load. From calculations based on the results of actual practice, the author has arrived at 9·5 per cent. as the ratio of thermal equivalent of watts at the dynamo terminals to heat contained in steam supplied which would obtain in a well-regulated central station, under ordinary conditions of working in England.

Taking as before 1 lb. of coal of a calorific value of 14,500 thermal units, allowing a boiler efficiency of 70 per cent., 10 per cent. stand by losses, 9·5 per cent. efficiency of steam dynamo, and 10 per cent. loss in distribution, not more than about 4·4 lbs. of coal should be consumed per kilowatt-hour, delivered to consumer's terminals.

But this figure is not approached in practice, except in one instance by Mr. R. E. Crompton, who states that at Kensington Court he burns 5·5 lbs. of coal per kilowatt-hour delivered all the year round; but he states that in doing this he forces his boilers, although it is not easy to appreciate the exact meaning of forcing a boiler Certainly, forcing a boiler usually results in a greater evaporation at a greater consumption per lb. of water evaporated, as it is well known that a boiler works most economically at about three-quarter load.

Prof. Kennedy has obtained some very good results in the generating stations of the Westminster Electric Supply, but not approaching the figure above arrived at. Mr. Druitt Halpin stated, in the course of some remarks at Nottingham last year, that an analysis of the Board of Trade returns of electric light companies showed an evaporation per lb. of coal of only 4 lbs. of water in the

best example, and of one, or less than one, in the worst. This anomaly is difficult to account for, it is usually ascribed to a low load factor, but this hardly seems reasonable.

Take, for instance, the working of a station of the London Hydraulic Power Company. The plant consists of boilers, engines, and pumps combined, and accumulators which in practice only act as equalisers. The efficiency of the boilers, the stand-by losses, and the loss by radiation will be about the same as in the case of an electric generating plant, at least, there is no reason why they should be different. But the engines will probably be more economical because, although they run at a diminished speed where the demand on the mains is small, they always work at full load per revolution; of course, the engine efficiency is not quite so good at slow speed as at high, but even at a slow speed an engine working at full load per revolution must compare favourably with one doing the same total work in horse-power hours at double or three times the speed. Moreover, at an hydraulic power station it is generally practicable to use triple expansion condensing engines.

As the thermal efficiency of steam engines, under such working conditions as obtained in central power producing stations, is extremely difficult to determine with any accuracy, it may be of interest to arrive at their figure by calculation of other efficiencies as nearly as they can be estimated.

Probably 9 lbs. of coal of calorific value of 14,500 thermal units per lb. is not an excessive figure to assume as the average performance of London central electric stations per kilowatt-hour, paid for by the consumer.

Now, 1 kilowatt-hour is equal to about 3,420 thermal units. Adding 11 per cent. for loss in distribution, and allowing 1·25 as the counter efficiency of the dynamos, there should appear on the crank shaft of the engine, so to speak, the equivalent of about 4,750 thermal units. But to effect this 9 lbs. of coal have been burnt, liberating 145·00 × 9 = 130,500 thermal units, so that the efficiency or non-efficiency of working of boiler and engine, together with attendant stand-by and radiation losses, are responsible for 96·2 per cent. of the heat energy of the coal consumed.

(To be continued.)

NEW PATENTS—1894.

10,214. "Gas and oil engine exhaust purifier." W. Habgood and S. C. Smith. Dated May 28th.

10,219. "Improvements in or relating to valve gear for gas, petroleum, or the like engines." H. J. M. Mellor and J. Taylor and Sons, Limited. Dated May 28th.

10,228. "Improvements in deodorising and purifying sewage or other waste liquors containing organic matters, in combination with generating and storing electricity, and in means or apparatus therefor." W. H. Hill-Hartland. Dated May 28th.

10,242. "An electric switch." W. Hearn and C. R. Gatehouse. Dated May 28th.

10,292. "A novel mode of illuminating watches, clocks, compasses, barometers, and similar instruments boxed up in metal cases by means of electricity." J. Manger and E. Mojon. Dated May 28th.

10,293. "A portable electric lamp." J. Manger and E. Mojon. Dated May 28th.

10,331. "Improvements in conductors for electrically propelled tramway and railway vehicles." F. B. Behr. Dated May 28th.

10,332. "An improvement in regulating apparatus for electric arc lamps." S. J. Suter. Dated May 28th.

10,353. "Improvements in pendant fittings for electric lamps." J. Morris, jun. Dated May 28th.

10,364. "Improvements in electrical devices suitable as meters, motors, dynamometers, and the like." E. Dragoumis. Dated May 28th.

10,384. "Improved carbon for electric lighting and other electrical purposes." G. S. Orson. Dated May 29th.

10,386. "Improvements in or applicable to clocks for operating electrical alarms." F. Fritz. Dated May 29th. *(Complete.)*

10,393. "Improvements in arc lamps and similar appliances." E. A. Claremont. Dated May 29th. *(Complete.)*

10,425. "Improvements in electrical transformers." J. A. Kingdon. Dated May 29th.

10,426. "Improvements in dynamo-electric machines." J. A. Kingdon. Dated May 29th.

10,463. "Improvements in cells or boxes of electric batteries." J. M. Moffat. Dated May 30th.

10,487. "Improvements in electrical measuring and signalling instruments." H. W. Sullivan. Dated May 30th.

10,490. "Improvements in the method of and apparatus employed for heating steel wire by electric currents." J. Platt. Dated May 30th.

10,515. "Improvements in dynamo-brushes." W. H. Fleming. Dated May 30th. [Date applied for under Patents, &c., Act, 1883, Section 103, November 13th, 1893, being date of application in United States.]

10,524. "A novel arrangement of screens and shades with means for affixing same to lamps, such as candle, oil, electric, incandescent, or other, such screens or shades being adapted for holding and supporting flower sprays or other ornamental objects." J. H. Rosoman, trading as Smethurst & Co. Dated May 30th.

10,565. "Phase transformers for electric currents." S. P. Thompson. Dated May 31st.

10,586. "Improvements in wall sockets for electric lighting." G. C. Lundberg. Dated May 31st.

10,590. "A combined switch and holder for an electric glow lamp." The Edison and Swan United Electric Light Company Limited, and C. F. Proctor. Dated May 31st. *(Complete.)*

10,594. "Improvements in or in connection with magneto-electrical telephones." M. Frank. Dated May 31st. *(Complete.)*

10,634. "Improvements on arc lamps." J. W. Rogers. Dated June 1st.

10,658. "Improvements in electric chimes." F. W. Golby (Communicated by A. Neumann, Germany.) Dated June 1st *(Complete.)*

10,659. "Improved apparatus for the suspension of incandescent electric lamps." F. W. Golby. (Communicated by A. Neumann, Germany.) Dated June 1st. *(Complete.)*

10,660. "Improvements in or relating to incandescent electric lamps." F. W. Golby. (Communicated by A. Neumann, Germany.) Dated June 1st. *(Complete.)*

10,672. "An improved device for casting electric accumulator plates." C. Hampel. Dated June 1st.

10,687. "An improved electric fire-alarm apparatus." L. Borel. Dated June 1st.

10,701. "Improvements in electrical connections for marine purposes." C. S. Snell. Dated June 1st.

10,745. "A continuous magnetic motor." I. Carruthers. Dated June 2nd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

6,000. "Improved methods for effecting the electro-fusion of steel and its alloys." B. H. Thwaite. Dated March 21st. The inventor superposes one crucible over another. At the bottom of the upper of the two crucibles there is an opening provided by which any fused metal in this crucible can flow into the lower crucible or chamber as fast as fusion takes place. Through the sides of this crucible are passed positive and negative carbon electrodes, which are so arranged that the scrap or other steel can be easily and continuously fed. 9 claims.

6,306. "Improved electric current meter." S. E. Nielsen. Dated March 24th. Consists in a counter or integrating mechanism of any suitable construction, which is actuated by a wheel driven by a rotating disc, but which is so constructed and so arranged in relation to such disc that the speed with which it is actuated thereby varies with the amount of current passing at the time. 2 claims.

6,780. "Improvements in secondary batteries." V. C. Doubleday. (A communication from abroad by M. Sussmann, of Neuruppin.) Dated March 30th. Claims:—1. Active material for secondary batteries made of finely powdered lead, lead oxide, or salt of lead, in combination with inert porous material, such as pumice stone or the like, and with binding material such as dissolved India-rubber, gutta-percha or the like, substantially as described. 2. A conductor for a secondary battery plate consisting of a body of lead or other suitable material with upstanding edges and teeth or tongues projecting on each side, and holes, substantially as and for the purposes set forth. 3. A secondary battery plate consisting of a conductor made as secondly claimed, and active material as firstly claimed, applied to the sides, and filling the holes in the conductor and compressed, substantially as set forth.

9,641. "Busy signal for telephone circuits." E. J. Hall and F. A. Pickernell. (Under International Convention.) Dated October 13th 1892. The main object is to provide convenient and suitable means, by the aid of which the occupied state at one portion of a switchboard of a circuit with which connection is desired, may be automatically indicated to the operator at another portion of said switchboard who is seeking such a connection, and also simultaneously announced (preferably in spoken words) to the customer or sub-station attendant who desires to communicate, but the latter part of said operation alone is also frequently useful and desirable.

10,015. "Improvements in apparatus for use in the utilisation of electrical energy for culinary purposes." R. E. B. Crompton and H. J. Dowsing. Dated May 19th. Claims:—1. The manufacture and use of metallic heating surfaces, with enamel backing forming a supporting, fixing and insulating medium for wire or strip conductors of electricity for the purpose of heating said surfaces, and with corrugated, fluted, or projecting parts adapted to admit of ready escape of steam or moisture generated, by way of the channels so provided, substantially as and for the purpose set forth. 2. The combination, arrangement and use of parts of an electric heating or toasting apparatus, substantially as and for the purpose set forth.

24,864. "Improvements in and relating to dynamo-electric machines." Elihu Thomson. Dated December 27th. The principle of the invention is to make the current which flows in the armature winding, under load, so act as to produce a field of force in which the armature winding moves, and which field will be in proportion to the load on the armature, and therefore increases the electromotive force, or counteracts any decrease of electromotive force which might be suffered under load. This is accomplished by placing opposite those parts of the armature which become polarised by the currents flowing therein, iron masses or what might be called dead poles, which only become active when the armature is under load. 13 claims.